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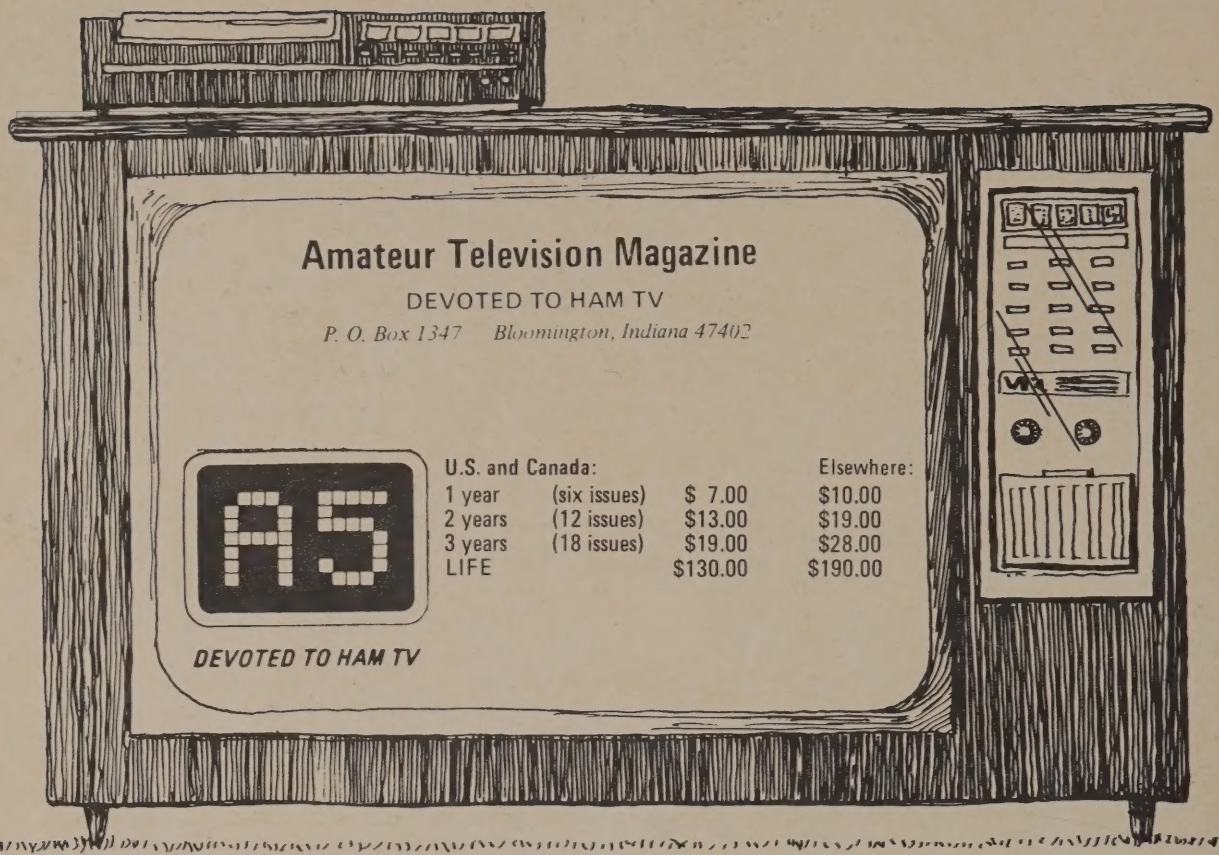
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A LOW-COST MODULAR RECEIVER FOR DOMSAT VIDEO

Application Note #8
July 1979
One Dollar

by H. Paul Shuch
Chief Engineer
MICRO COMM
INNOVATORS IN MICROWAVE COMMUNICATIONS
14908 SANDY LANE, SAN JOSE, CA.
95124

Prepared for presentation at WESCON/79

INTRODUCTION

The technological revolution which is making possible the distribution of television programming via satellite has been discussed previously in this Session.[1] Here we will explore the tradeoffs involved in designing a wideband tunable FM video receiver, for processing and displaying DOMSAT (Domestic Communications Satellite) signals.

It should be recognized that there are at least as many conflicting receiver design philosophies as there are microwave engineers, and no claim is made that the concepts presented here are necessarily superior to any other approach. Nontheless, this receiver does provide adequate performance at low cost, and the tradeoffs encountered are typical of those with which others have had to deal. It is hoped that documenting this effort will help to dispel some of the mystique of microwave receiver design.

SIGNAL CHARACTERISTICS

Unlike the vistigal-sideband AM video standard used for terrestrial TV broadcast, DOMSAT video incorporates a wideband FM format, with audio multiplexed onto a subcarrier prior to modulating the composite. The resulting wideband channel (see Table I) affords considerable "FM Advantage" (signal-to-noise enhancement for a given carrier-to-noise ratio); however, the bandwidth and format tend to complicate the receiver design task.

Were a signal consisting of vestigal-sideband AM video with intercarrier narrow-band FM audio available from the satellites, receive processing would involve merely heterodyning the selected channel in the 4 GHz transmission band against a stable microwave local oscillator, and applying the VHF difference signal directly into the tuner of a conventional TV set. Unfortunately, with DOMSAT signals as they are currently formatted, such a downconversion process would merely spread unintelligible sidebands across six adjacent TV channels.[2] Thus it becomes necessary to design a complete receiver, including heterodyne conversion stages, demodulators, video and audio processing circuitry, to recover and display satellite TV.

FREQUENCY AGILITY

It will be noted from Table I that the downlink band used by most North American DOMSATs is 500 MHz wide, and that for a given antenna polarization there will be present up to twelve video carriers, spaced 40 MHz apart (see Figure 1). That these signals are of extremely low amplitude complicates the design of the earth station's antenna[3] and low noise preamplifier[4], but we will assume for the

TABLE I
Typical DOMSAT Signal Characteristics

VIDEO CARRIER:	
Channels	24
Adjacent Channel Spacing	40 MHz
Orthoginal Channel Spacing	20 MHz
Frequency Band	3.7 - 4.2 MHz
Peak Deviation	10.25 MHz
Max. Video Frequency	4.2 MHz
Pre-Emphasis Curve	CCIR 405-1
AUDIO SUBCARRIER:	
Frequency	6.8 MHz
Peak Deviation	75 KHz
Max. Audio Frequency	15 KHz
Pre-Emphasis Time Const.	75 uSec
ENERGY DISPERSAL:	
Waveform	Triangular
Frequency	30 Hz
Peak Deviation	750 KHz
COMPOSITE:	
EIRP	+65 dBm
Path Loss	-196 dB
99% Power Bandwidth	36 MHz
Received Spectral Density	-206 dBm/Hz

moment that an adequate signal-to-noise ratio exists at the input of the receiver to permit signal recovery. The problem at hand, then, is to select a particular 40-MHz wide channel from among 12 such signals in a 500 MHz wide band, while adequately attenuating the adjacent channels.

A Tuned Radio Frequency (TRF) approach, with detection occuring directly at the downlink frequency, would require readily tunable bandpass filters of high Q (to accomodate the 1% or so channel bandwidth) and skirts steep enough to reject adjacent channels. Tuning requirements rule out both LC and resonant cavity filters, suggesting the use of Yttrium-Iron-Garnett (YIG) sphere resonators for channel selection.

Although YIG filters can be readily bias tuned, their cost and the complexity of the required driving circuitry tend to rule them out for private terminal applications. Furthermore, it is far easier to tune a single oscillator than a bank of filters. This suggests heterodyne downconverting a selected channel into a fixed intermediate frequency, at which demodulation may take place.

I-F SELECTION

The selection of intermediate frequencies for superheterodyne receivers involves careful attention to the required and realizable mixer bandwidths, image rejection criteria, demodulator circuit capabilities and tuning constraints. These various considerations tend to be mutually exclusive, but it has been shown [5] that for narrow-band systems a reasonable compromise is achieved by selecting an intermediate frequency approximately one-tenth the frequency of the incoming signal. Although DOMSAT video hardly qualifies as a narrow-band service, we can use the one-tenth rule of thumb to establish a starting point. For a 4 GHz input signal, this suggests a UHF IF. However, the various demodulator circuits compatable with wideband FM video (quadrature detector, ratio detector, Foster-Seely Discriminator, phase-locked loop and the like) are all most readily realized in the lower portion of the VHF spectrum. An obvious solution is to utilize dual downconversion, with first and second IFs near 400 and 40 MHz respectively.

In fact, numerous experimental DOMSAT video terminals have adopted the above frequency scheme, many employing UHF TV tuners for the second downconversion. The drawbacks to such an approach include the typical UHF tuner's restricted channel bandwidth, relatively high noise figure and poor local oscillator stability. Nontheless, when cost is the primary design constraint, these problems can be circumvented.

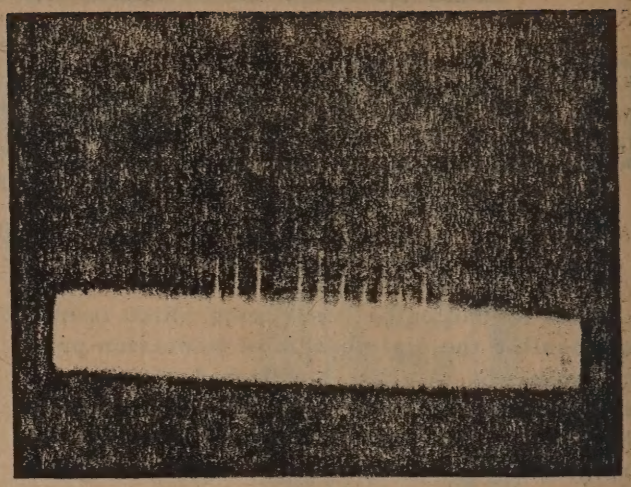

FIGURE 1 : Spectral display of a 4 GHz DOMSAT downlink, recovered on a 4.7 meter antenna, and amplified by a GaAs FET Low-Noise Amplifier (LNA). Horizontal deflection is 100 MHz/div, and vertical sensitivity is 10 dB/div. Eleven video carriers, along with their associated FM sidebands, are visible. Note that the fourth channel above the bottom of the band is vacant. Otherwise, channel spacing is 40 MHz, and carrier-to-noise ratio appears to be on the order of 10 dB.

Not so readily resolved is the input filtering requirement which such a frequency scheme imposes. Assuming low-side first LO injection and top-channel reception, the first conversion will generate an image frequency which falls a mere 300 MHz below the bottom edge of the downlink passband. An input filter capable of providing adequate passband flatness and minimal insertion loss over the 3.7 to 4.2 GHz band is unlikely to provide adequate image rejection, if a 400 MHz first IF is utilized. One may wish to raise the first IF high enough to separate the image frequency band well away from the downlink passband, thus simplifying input filtering.

In fact, if the Low-Noise Amplifier (LNA) which precedes the receiver utilizes a wave-

guide input, then an image filter already exists. Rectangular waveguide is a high-pass transmission line. If low-side first LO injection is used, and the first IF carefully selected, the LNA's waveguide input will itself reject the image frequency.

Most commercial LNAs utilize an EIA standard WR-229 waveguide input. This guide has a lower $TE_{1,0}$ cutoff frequency near 2.5 GHz. This cutoff frequency is about 1.2 GHz below the bottom edge of the receiver's required passband, so input losses will be minimal. But a first IF of, say, 1.2 GHz will place the image frequency as far below cutoff as the input passband is above cutoff. The image thus ends up quite far down the waveguide high-pass filter's skirts, and may effectively be ignored.

True, the fixed 1.2 GHz first IF requires that the first LO be tunable, but we mentioned earlier that it's far easier to tune a single oscillator for channel selection than a bank of filters. And even at the top of the downlink passband, where the first LO must be tuned up to 3 GHz, the image at 1.8 GHz is sufficiently far below cutoff that a 12 cm long input waveguide will afford on the order of 60 dB of image rejection. [6]

Another signpost pointing to the selection of 1.2 GHz as a first IF is realizable amplifier Q. The 3 dB bandwidth of the IF amplifier string must be greater than or equal to the 20 dB channel bandwidth, to avoid unduly attenuating significant sidebands. Assuming a channel bandwidth of 40 and an IF of 1.2 GHz, this dictates an effective first IF Q of 30. This value is readily realized with microstripline circuitry.

Despite the obvious economic advantages of the modified UHF TV tuner conversion scheme, it was decided to employ a 1.2 GHz first IF in the Microcomm DOMSAT video receiver. But what of the second IF - is it similarly constrained by the wide downlink passband? Actually not. With channel selection occuring in the first downconversion, the second IF need be only wide enough to accomodate a single video channel. Downconverting the 1.2 GHz first IF to any desired VHF frequency will allow ample second-conversion image rejection with simple IF filtering, while providing adequate bandwidth to pass the 40 MHz FM composite.

Since the communications industry has long utilized 70 MHz as a standard IF for microwave

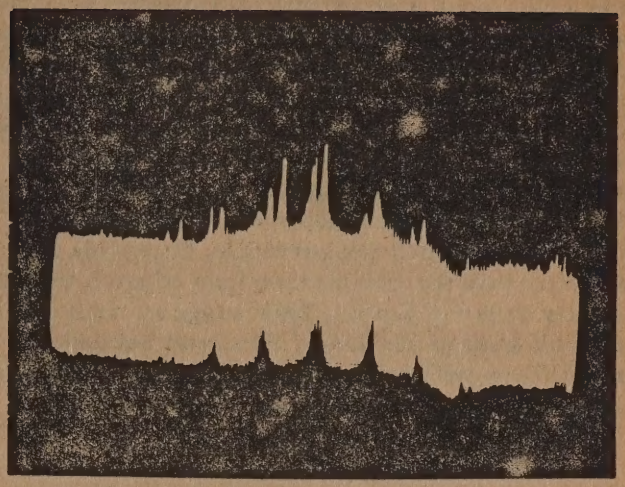

FIGURE 2 : Spectral display of a single wideband FM video channel after dual-downconversion to a 70 MHz second IF. Horizontal deflection is 3 MHz/div, and vertical sensitivity is 10 dB/div. This is the composite FM signal from which video and audio are to be demodulated.

---

links, it was decided to employ a 70 MHz second IF in the DOMSAT video receiver. This makes it possible to utilize any of the readily available 70 MHz wideband FM IF strips to demodulate the video information.

GAIN DISTRIBUTION

Gain partitioning for the DOMSAT video receiver depends upon the available power from the satellite, the threshold sensitivity of the demodulator circuitry selected, and the gain of the receive antenna utilized. It has been shown that, for the illumination contours typical of most North American DOMSATs, an optimum private-terminal antenna will exhibit on the order of +41 dBi gain. [7] Given the EIRP and path loss numbers listed in Table I, it appears that the signal level available to the LNA will be on the order of -90 dBm.

The input threshold for a typical Phase-Locked Loop (PLL) integrated circuit operating as an FM demodulator at 70 MHz is on the order of -20 dBm. This suggests that between the antenna and the demodulator, roughly 70 dB of conversion gain is required.

There are three sources of gain available between the antenna and the PLL. These include

the LNA, first and second IF amplifiers. There are similarly three sources of loss in the system: the insertion loss of the transmission line which connects the LNA to the receiver, and the conversion loss of the first and second mixers. For a typical home installation, the feedline insertion loss may be on the order of 6 dB, and if double-balanced diode mixers are used for the two frequency conversions, it is safe to assume that the conversion loss of each will be on the order of 7 dB. This suggests that the overall gain of the LNA, first and second IF amplifiers will need to total 90 dB, for adequate DOMSAT video reception.

In the interest of maximizing system stability and dynamic range, it is desirable to distribute the required 90 dB of gain uniformly between the RF and two IF frequencies. A 30 dB gain LNA is clearly feasible at 4 GHz, and would require three stages of GaAs FET amplification. This ammount of LNA gain is sufficient to adequately mask the noise temperature contribution of the feedline and receiver, allowing the low noise temperature of the FETs to predominate (see Reference 4). Similarly, it is practical to achieve the desired 30 dB of 1.2 GHz gain by cascading two stages of ion-implanted silicon bipolar transistor amplification. At 70 MHz, the required gain is readily available from thin-film wideband gain blocks produced by a number of different vendors.

A block diagram for the dual downconversion portion of the DOMSAT video receiver, partitioned in accordance with the foregoing discussion, is shown in Figure 3 below.

CONSTRUCTION OF CONVERSION CIRCUITRY

During the initial system development phase of any new product, it is common practice to build a number of different amplifier, mixer, filter and oscillator circuits, each connectorized for coaxial input and output, and with each circuit separately boxed and shielded. A modular developmental system provides the engineer with the flexibility of changing one or more circuits without having to disrupt the rest of the system. Microcomm's earlier efforts at modular receiver development have been documented previously. [8]

But modularization has advantages for a production system as well. If every function represented by a block in Figure 3 is implemented in a separate, shielded module, then isolation between stages is maximized, and the crosstalk and stability problems associated with stray RF coupling can be eliminated entirely. Further advantages are realized in the area

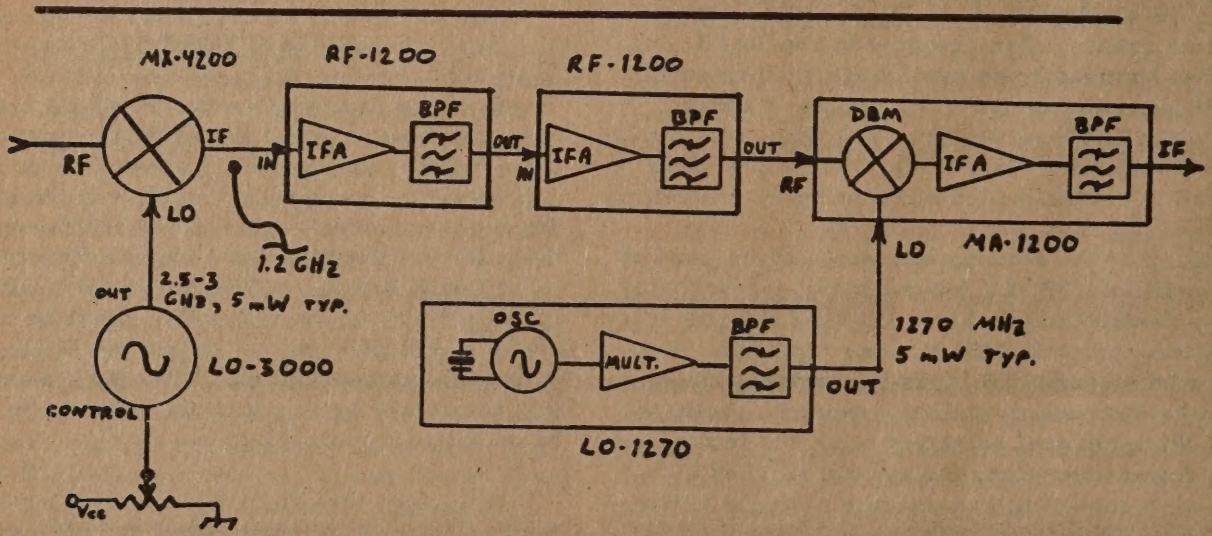

FIGURE 3 : Block diagram of the heterodyne downconversion portion of the DOMSAT video receiver. Shown at left is the 3.7 - 4.2 GHz input terminal from the LNA and feedline. The 70 MHz IF output at right feeds the baseband demodulator and processing circuitry (see Figure 7). The potentiometer shown at the lower left represents the resistive voltage divider which tunes the first Local Oscillator for channel selection. Gain partitioning of the various blocks is discussed in the text.

of maintainability. Should a receiver fail, fault isolation by module substitution becomes a viable troubleshooting technique. And of course a modular system maximizes user flexibility, by allowing customers to assemble from standard modules a custom system designed to meet their precise needs.

The specifications of the modules developed to implement Figure 3 appear here as Table II. Each of these modules employs microstripline construction, as shown in Figure 4, to minimize component count and assure duplicability.[9]

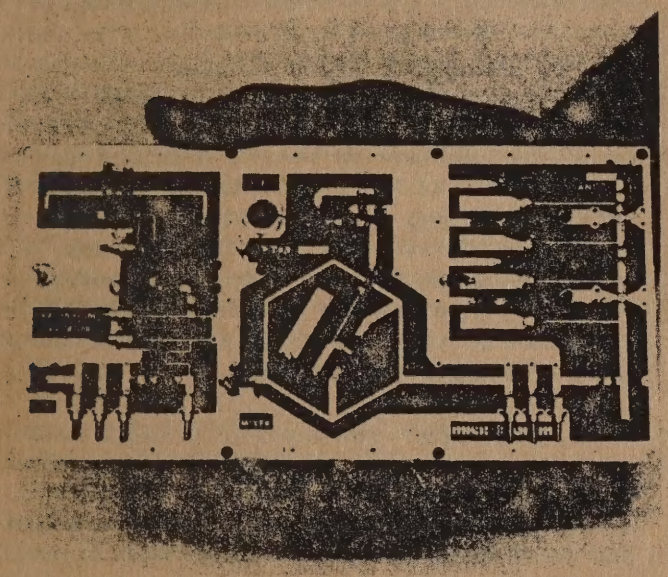

FIGURE 4 : Typical microstripline circuit module used for satellite video downconversion. Each module in the receive system is mounted in its own shielded enclosure, and all are interconnected via coaxial cable as discussed in text.

TABLE II
Typical Parameters for Conversion Modules

MX-4200 DOUBLE-BALANCED MIXER:	
Input Frequency	3.7 - 4.2 GHz
LO Frequency	2.5 - 3.0 GHz
Intermediate Frequency	1.2 GHz
Isolation	20 dB
Conversion Loss	7 dB
LO-3000 VOLTAGE CONTROLLED OSC:	
Output Frequency	2.5 - 3 GHz
Output Power	+7 dBm
Spurious Rejection	20 dB
Tuning Voltage Range	3 - 10 VDC
Supply potential	+13.5 VDC
RF-1200 AMPLI-FILTER:	
Center Frequency	1.2 GHz
3 dB Bandwidth	50 MHz
Gain	15 dB
Noise Figure	2 dB
Supply Potential	+13.5 VDC
LO-1270 LOCAL OSCILLATOR:	
Output Frequency	1270 MHz
Stability	± 0.001%
Power Out	+7 dBm
Spurious Rejection	40 dB
Supply Potential	+13.5 VDC
MA-1200 MIXER-AMPLIFIER:	
Input Frequency	1200 MHz
LO Frequency	1270 MHz
Intermediate Frequency	70 MHz
Conversion Gain	20 dB
3 dB Bandwidth	40 MHz
Supply Potential	+13.5 VDC
Isolation	20 dB

BASEBAND PROCESSING

Before the wideband FM composite shown in Figure 2 can be displayed, several processing steps are necessary. The 70 MHz IF signal will of course be demodulated first, and this may be readily accomplished using a monolithic PLL in a standard circuit.[10] The output waveform from the PLL will contain both the video waveform and the modulated audio subcarrier, but superimposed on these will be found the 30 Hz triangular energy dispersal waveform added to all DOMSAT downlink signals as an interference reduction technique. This waveform is quite evident in the oscilloscope display at right.

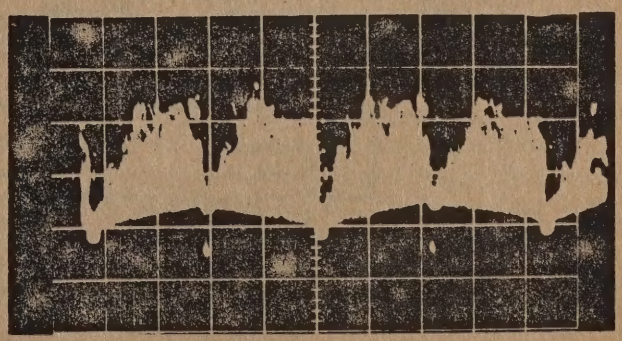

FIGURE 5 : Baseband output of the PLL Demodulator. Presence of the Energy Dispersal waveform on the video composite is evident.

Prior to attempting to remove the energy dispersal waveform, it is desirable to amplify the rather feeble video level available from the PLL Demodulator, and this may be accomplished using a single monolithic TV video amplifier IC. Next an emitter follower permits splitting off the 6.8 MHz audio subcarrier, for demodulation in a standard TV Sound IF microcircuit, whose associated circuitry is modified slightly for compatability with the higher carrier frequency and peak deviation used on satellite audio.

After passing through a de-emphasis filter and passive video low-pass filter, the video waveform may finally be applied to a diode clamp circuit, which will remove the energy dispersal waveform (see Figure 6, at right). An emitter follower then establishes the desired 75 ohm video output impedance to drive recording or display circuitry, as required.

A block diagram for a complete baseband processing subsystem is shown in Figure 7, below. This circuit can be constructed on a single printed circuit board, and incorporated into a complete DOMSAT video receiver by simply interfacing it to the downconversion circuitry shown in Figure 3.

DISPLAY OPTIONS

An ideal DOMSAT video receiver for the home earth station market would provide an intercarrier audio, vestigal sideband RF output

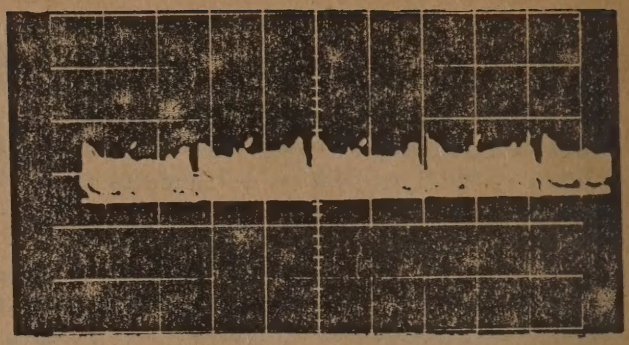

FIGURE 6 : The DC Restorer is simply a diode clamp circuit, which removes from the video waveform any vestiges of the Energy Dispersal waveform seen in Figure 5.

for direct interface to the user's VHF TV receiver. Such an RF output may be readily realized by using any of the available video modulator microcircuits developed for the TV game and home computer industries, and in fact the video and audio levels available from the baseband unit shown here are entirely compatable with such modulators.

Unfortunately, incorporating an RF modulator in a commercial DOMSAT video receiver would subject the entire receiver to FCC type acceptance in the United States. As more than one home computer manufacturer has discovered, the type acceptance procedure is burden-

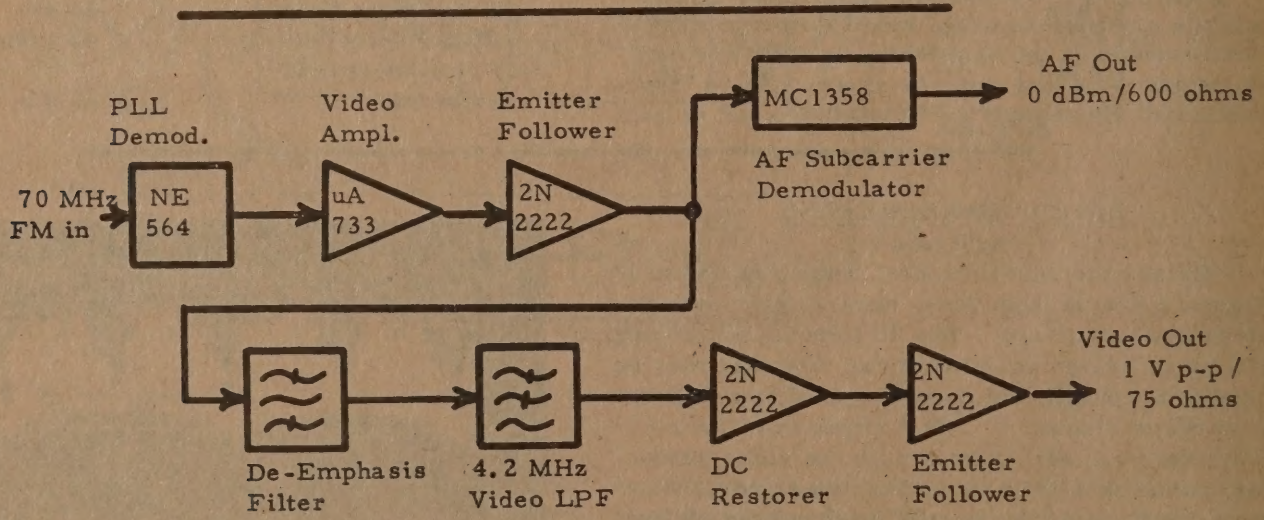

FIGURE 7 : Block diagram of the complete Baseband Processing portion of the DOMSAT video receiver. The above circuitry is driven by the output of the Downconversion Module Set (see Figure 3), and provides standard 1 volt video and 0 dBm audio outputs to an external modulator, studio monitor, or video tape deck.

some in the extreme, with bureaucratic delays often precluding a timely market entry. In addition, the resolution and clarity of most of the available low-cost video modulators leave quite a bit to be desired, and RF modulation would tend to degrade overall video quality noticeably.

A possible solution would be to provide the user with simply a video and audio output from the DOMSAT receiver, and allow him to display the receiver's output on a studio-quality TV monitor. However, few videophiles posess such a monitor, and the cost is prohibitive.

Fortunately, most videophiles do posess a video tape recorder (in fact, the owner of a home satellite earth station would most likely find it impossible to function without one!) and the average video recorder contains an extremely high quality RF modulator. Allowing the user to interface his DOMSAT receiver to the TV via a video recorder provides an ideal solution to the type acceptance dilema. And those users who have no recorder are of course free to add an external RF modulator, any number of which are available in kit or assembled forms.

EQUIPMENT AVAILABILITY

Once priced in the tens of thousands of dollars, DOMSAT video receivers are now being brought within the reach of the American consumer. The conversion modules shown in Figure 3, for example, have since late 1978 been available to the experimenter at $1000 complete, and to the OEM at significantly lower prices in production quantities.

It is expected that by the end of 1979, a complete, fully tunable DOMSAT video receiver. utilizing the above conversion modules and a baseband unit such as that blocked out in Figure 7, will be available to the consumer at under $2000. This receiver will be fully packaged and assempled, including power supply, tuner, control circuitry and interconnecting cables. Such a receiver promises to make possible for the first time a complete, consumer-grade earth station, including antenna and LNA, for under $4000. What price breakthroughs will follow, we can only begin to guess!

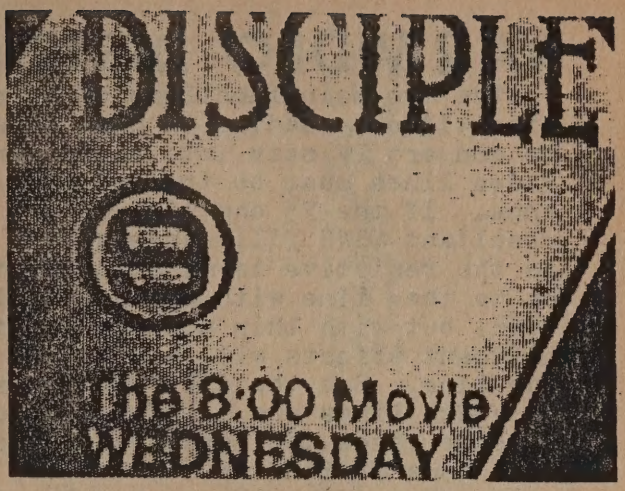

FIGURE 8 : The video output of the baseband unit, displayed on a TV set with the aid of the RF Modulator in a video cassette recorder. Most DOMSAT viewers find the clarity and resolution of satellite video clearly superior to network video which is distributed by multiple terrestrial microwave hops.

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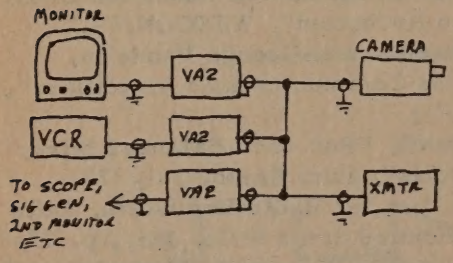
VA2 VIDEO DISTRIBUTION AMP

The two main functions of this module are to buffer off a 75 ohm line without loading it down to drive other monitors or devices, and to convert TV sets into video monitors or ATV repeater receivers. Video lines must be treated just like a transmission line and antenna. If the 75 ohm line is not terminated in 75 ohms, then the resultant VSWR fill cause ghosts and poor color. Usually the xmtr is the resistive termination at the end of the video coax. Taping on to the line with another monitor or 75 ohm load will give a VSWR, but with this modules input impedance being over 2K no significant effects will occur. Up to 8 VA2 modules can be taped into the line. See the distribution system sketch below.

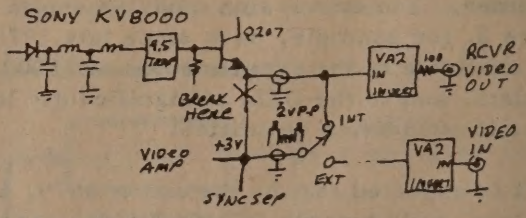
Video lines are 1.0 V p-p negative going sync into 75 ohms. But in some cases the level may be too low or the device to be driven such as a TV/monitor may need up to 2.5 volts p-p, or take positive going sync. The 1K pot may be adjusted for the desired output level and has a voltage gain range of 2 to 3. Max input is 1.5 v p-p. The output must be terminated at the end of the 75 ohm coax with a resistive 75 ohms to work properly. Make sure that the device to be driven has this temination with a ohmeter and also that it has no voltage present at the input connector before attaching the coax line. If there is voltage present use a series 100 mf cap (observe proper polarity) and add a 100 ohm resistor to ground from the connector center pin. Also check for proper polarity of the 100 mf VA2 input cap with respect to the line being taped into. Reverse it if the line DC voltage is above 2.4 v.

Use RG59 coax for runs over 2 ft for inter connections or to video sources and loads. RG 174 is fine, or shielded cable for shorter runs. Connect to any supply between 11 and 18 vdc at 25 ma per module. Solder in a buss wire jumper between hole "J" and either the non inverting (+) or inverting (-) hole as your application requires. Adjust the 1K video gain pot for a 1 v p-p output.

DISTRIBUTION SYSTEM



SAMPLE TV/MONITOR CONVERSION



R9 MAYBE PARALLED WITH 22K TO GIVE +3VDC OUTPUT TO RESTORE THE BIAS LOST FROM BREAKING Q207 EMITTER LEAD.

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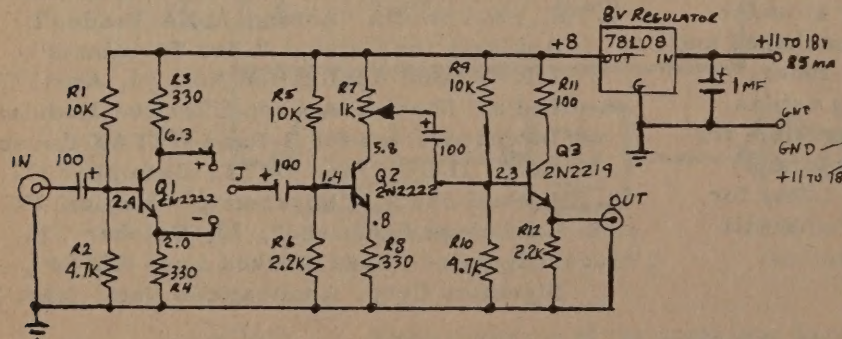

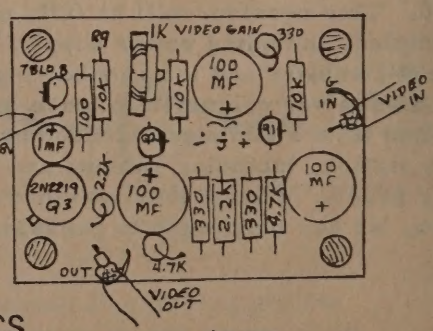

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432 MHz GaAs FET Preamplifier Schematic

SEE: "HAM RADIO MAGAZINE" APRIL 1978, PAGES 22-27 FOR UNBALANCED CIRCUIT - DESIGN

FRED CARRESS, KBAHE IS BUILDING THIS PREAMP. ASK HIM ABOUT RESULTS AND DETAILS.

432 PREAMP

Use 2ea #32AWG - Place Together and Wind around Ferrite Bead
4 Turns - Bead 1/8" DIA x 1/8" x 1/16" hole
Take the Bottom of one and tie the Top of the other Together and solder the 470 PF one lead remaining goes to the Drain the other to the Source

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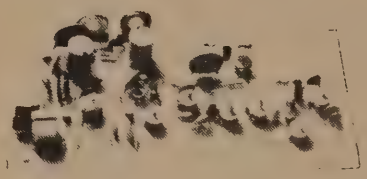
Solid State Fast Scan ATV Modules

The Basic Four Modules

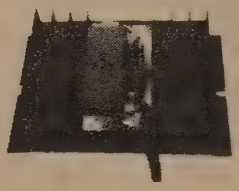


1. TXA5-4 ATV EXCITER/MODULATOR . . . . . **$89 ppd**

This wired and tested module is designed to drive the Motorola MHW-710 module in the PA5 10 watt linear amp. The crystal in the 100 mHz region keeps harmonics out of two meters for talk back. The video modulator is full 8 mHz for computer graphics and color. Requires 13.8 vdc reg @ 70 ma. Tuned with xtal on 439.25, 434.0, or 426.25 mHz. Provision for sync expanding.

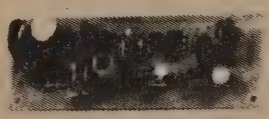
Two Freq . . . $115 ppd

CA-1 video carrier audio/18 mhz osc add $49



2. PA5 10 WATT ATV POWER MODULE . . . . . **$79 ppd**

The PA5 will put out 10 watts RMS power on the sync tips when driven with 80 mw by the TXA5 exciter. 50 ohms in and out, plus bandwidth for the whole band with good linearity for color and sound. Requires 13.8 vdc regulated @ 3 amps. MHW-710 . . . $50 ppd



3. FMA5 AUDIO SUBCARRIER GENERATOR . . . . . **$29 ppd**

Puts audio on with your camera video just as broadcast TV does at 4.5 mHz. Puts out up to 1 v p-p to drive the TXA5 or VM-2, 3, or 4 modulators. Requires low Z mic (150 to 600 ohms), and +12 to 18 vdc @ 25 ma. Works with any xmtr with 5 mHz video bandwidth.

4. TVC-2 ATV DOWNCONVERTER . . . . . **$55 ppd**

Stripline MRF901 (1.7 db NF) preamp and double balanced mixer module digs out the weak ones but resists intermods and overload. Connects between uhf antenna and TV set tuned to channel 2 or 3. Varicap tunes 420 to 450 mHz. Requires +12 to 18 vdc @ 20 ma.

Super sensitive TVC-2L with NE64535 preamp (.9db NF) stage . . . $79 ppd

TVC-4 ATV DOWNCONVERTER . . . . . **$89 ppd**

This is a packaged version of the TVC-2 converter with internal power supply. Has BNC input and F output connectors.

Also available with the NE64535 for $115 ppd

Size: 5 1/4 X 2½ X 7 inches.

♦♦♦♦♦♦♦♦♦♦♦♦♦ Package Specials ♦♦♦♦♦♦♦♦♦♦♦♦♦

TXA5, PA5, FMA5, and TVC basic module package . . . . . $239 ppd

OPTIONS: 2 frequency exciter . . . . . add $30
NE64535 low noise downconverter . . . . . add $30
Packaged TVC-4 downconverter . . . . . add $34

10% discount on 5 or more of one module ordered at one time to one address.

One of the toughest competitors at the Winter Olympics was no amateur.

To look at a Hitachi GP-4 camera and its under $1,000 price tag, you might think it was strictly an amateur camera. It's that small and light and easy to use.

But when you look at the pictures it makes, you know it's a pro. And you did look at GP-4 picture quality, everytime you "rode" down the bobsled or luge courses while watching ABC's coverage of the Winter Olympics. There were two GP-4's mounted on sleds and capturing all the heart-stopping action of those 80 mph downhill runs.

It took a special camera to live up to that assignment. Naturally, ABC tested bigger, more expensive cameras first. But the GP-4 was ideal for many reasons. It was one of the world's smallest, lightest, most rugged color video cameras. Its simple single tube design eliminated registration adjustments. And its award-winning Tri-Electrode Vidicon tube produced broadcastable pictures with low lag and outstanding color fidelity. Not to mention the GP-4's low light sensitivity and easy interface with a standard 3/4" portable VTR without modification. In fact, the only modification was the addition of a wide angle lens.

Not all the sleds survived, but those GP-4 cameras did. Battered but unbowed, they're still in use at ABC for training purposes. Now that's tough, and that's professional. That's Hitachi GP-4...the camera for all reasons...and all budgets.

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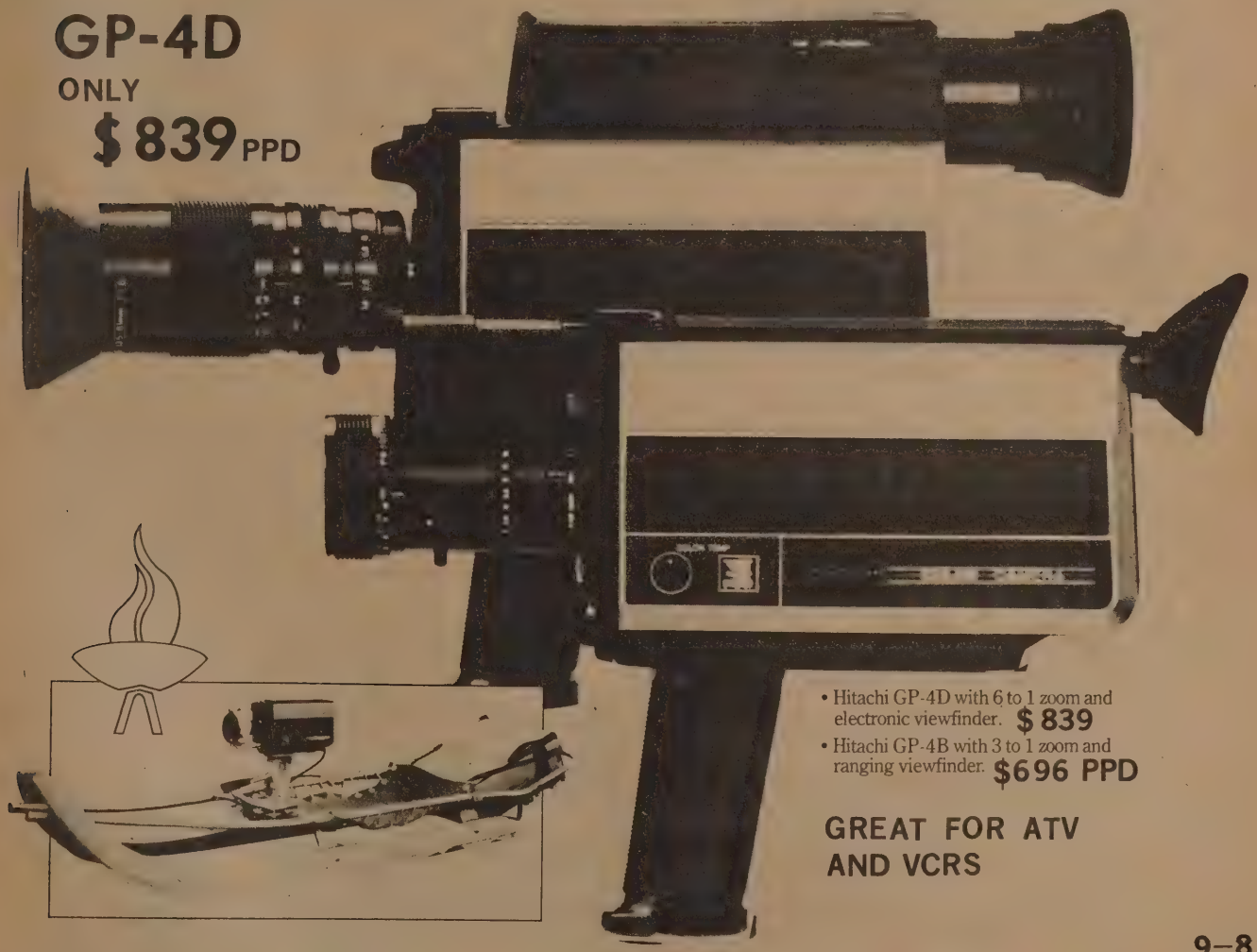

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- Hitachi GP-4B with 3 to 1 zoom and ranging viewfinder. **$696 PPD**

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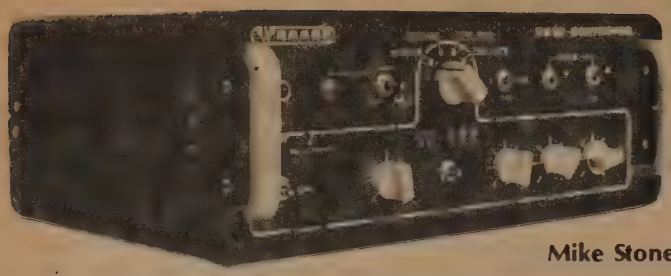


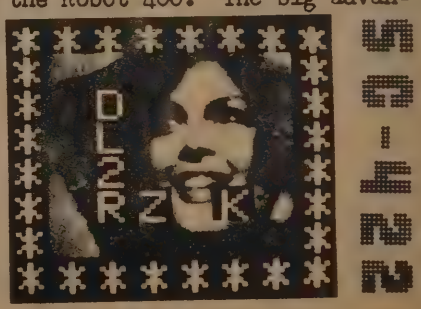
NEW VOLKER WRAASE SSTV SC-422 Review *

Mike Stone, WBØQCD

In wine, it's the french 67' Chateau d' Yqllem or the german 76' Dr. Thannisch Bernkasteller Auslese, in automobiles it's the Mercedes or Porche, in cigars it's Havanna or Jamacan Macanudo, but in Slow-Scan Television it's Volker Wraase's SC-422 Converter and matching keyboard! Many of you have never heard of the name. But, mark my word-before the year has ended you will be seeing more and more of these fantastic little machines on frequency. I feel so excited about this new product now available stateside for the first time, that I sold my Robot 400 SSTV Converter to acquire the system. I found it hard to believe that anything could top the 400 converter with it's already excellent picture reproduction quality and 4K memory. Well, move over Robot, here comes your new competitor!

I first became acquainted with DL2RZ's work when I began working many european SSTV stations who boasted of the SC-421 early model units. I saw "tricks" being done with the video that I never saw any stateside stations do. I wrote Volker Wrasse for some printed material, but the return mailing needed a german translator along to understand what was stated in the brochure. Then I worked ZS6BTD-Gerald in South Africa several times on 10 meters as he demonstrated his new 422 model. Meeting with Volker at the spring Dayton Hamvention for over two hours and carefully examining the SC-422 unit on display, I was sold! The next step was to contact the newly authorized U. S. distributor in New York. My contact with Mr. Walter Giesser at KW Control Systems, Inc. in Middletown, New York brought immediate results! It seems as though multi-million dollar company produces the "Piller" (TM) line of power control generators,frequency converters, redundant systems and diesel generators for the "computer world". Who are there customers? Only businesses like IBM, Commonwealth Edison, GTE, Lockheed, all kinds of insurance companies and universities. Mr. Giesser's "baby" is a unit that retails at a mere $8,350.00 that remotely analyses internal meters and leds. within the large power systems via Phoneline Slow-Scan Television. And, guess what is the heart of this "watchful eye" that saves thousands of dollars every day for the computer industry? Right, Volker Wraase's SC-422 converter. Well, knowing your interest is at a peak, lets continue on with the specifics of the review!

SC-422 Specifications; With experimentation being done on Color SSTV and Medium Scan Television, what could be more natural than a 2 memory converter? No need to buy extra boards of expensive chips and a nightmare of interface wiring, just flip the 3-way switch on the 422 and you take command of memory #1, memory #2 or a combined 256 rendering that will make your mouth drop when compared to the popular converters on the market today with unmatched resolution. To be fair, Robot's model 400 uses 256 rendering but displays only 128 pixels by 128 lines. The SC-422 has 16K RAM of memory and 128,000 bits of memory capacity in comparison to 4K & 65,000. The popular 400' model has 8 shades of grey levels where the SC-422 has 16 levels for better coloring and shading. #1 memory can be dumped on the air while you are "setting-up" memory #2. Interesting artwork can be formed by intermixing the two memories with proper individual pictures that can "lay" on top of each other. A surprise bonus became apparent on my first contact as when the sending station stopped his video, the picture automatically locked up in memory and did not paint "noise" as my previous unit! (No more, "sorry for the noise on top" routine). Unlike the generated grey scale on the bottom of the picture, the SC-422 employs its 8 level scale at the top of the frame with the belief that a picture not properly tuned until the bottom of the frame is a poor picture. An easy to read LED tuning indicator for the SSTV signal and built-in filter assures proper signal alignment. A tunable pot for correct syncing also allows copy of non-standard color and sync tones (other than 1200 hz. Sync, 1500 hz. black and 2300 hz. white). The Camera "see through" (FSTV) setup is similar to operation of the Robot 400. The big advantage is utilizing the two memories of storage. Individual controls for contrast and brightness align the camera for a proper picture. Black/White reversal is standard and a special built-in SSTV output filter for distortion-free out put of the sine wave signal really cleans up the act! For improved displayed pictures, a switchable Dot/Line blanking raster control is mounted on the rear of the unit which allows the operator to select a 256 dot raster or 128 line -- structure. This does not affect the outputted picture.



2 MEMORY SSTV Scan Converter

The converter itself is remarkably small and very lightweight. (12X4X7"). It is housed in a very attractive black and silver all aluminum cabinet. All solid-state, the unit also houses the power supply for the matching keyboard. All connectors are standard SO-239, BNC etc. except for the audio cables which are supplied. An optional accessory tool that would be disired by those not getting the keyboard or for those who like to draw, is a "video-pen" that attaches to the converter and allows writing on the monitor screen (bit change). Certainly, this SSTV converter is ahead of its' time and is the "Cadillac" of Slow-Scan Equipment. Unfortunately, not all of us can afford "Cadillacs", but considering the design preparation, size, memory, filtering, special effects and not to mention overseas shipments, duty tarriffs, distributor advertising and promotion and "at home" (NY) repair service, it isn't a bad buy at $1,184.00. Volker Wraase SC-422 SSTV Converter carries a one-year warrantee on all parts and materials.

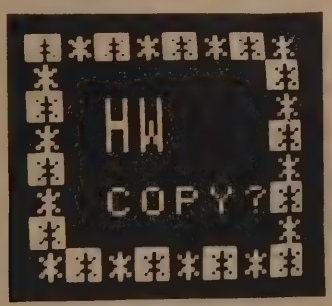
KEYBOARD

KB-422

SC-422

A further compliment to an already "fantastic" system, is the KB-422 SSTV Graphic Keyboard. Gold-plated contacts represent "nothing but the best" for this Ascii keyboard. It has the standard 26 character alphabet, ten numbers including a slant Ø and 28 special characters for punctuation and special effects artwork. The unit displays 8 lines (small format) and 4 lines in the large format (Same across). A switchable Black on White (BOW) and White on Black (WOB) control backgrounds the character which can be alternated with each chacter (unlike other SSTV keyboards that can only "reverse" the entire frame). Okay, ready for the BIG NEWS? The graphics can be superimposed over any video picture in memory! Now think of the possibilities! The unit has a non-interfering but recognizable "cursor" that tells you where you are for insertion. The special "delete" key erases any character or background video not desired. The KB-422 Keyboard is so small and lightweight it will fit anywhere. The KB-422 can only be used with the SC-422 SSTV Converter and retails at a reasonable $296.00 including one-year warranty. You should see the amazement when I return the sending stations self-portrait with his callsign and name typed in with the picture. The usual response is "What type of computer are you running there?"

In summary, it is an expensive system. But when compared with a new Robot 400, additional required memory boards and a similar SSTV keyboard-you are money ahead and with more features with the SC-422/KB-422 SSTV System. My "hat is off" to designer/builder Volker Wraase, DL2RZ for a very worthwhile contribution to Amateur Television! Now all that is left to tell you is where to get them.



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Walter Giesser, R&D Dept.

SSTV - DXCC - WAS

WAS-SSTV and DXCC-SSTV. Two highly prized awards which require a lot of hard work will be offered by ATV Magazine starting Jan 1, 1981. A tally form and map were printed in the July issue and extra copies are available from A5. RULES: Only contacts made after January 1, 1981 (After 00:00:01 Z Jan 1, 1981) will be allowed. This gives everyone equal chance to get numero uno!. Contacts must be a complete two way SSTV (or other video mode, ie medium scan). Each QSO must have the following elements; 1)complete exchange of two way video, including call, mug shot and RST. 2) QSL confirming exchange, or letter or other instrument, ie cassette which can be submitted as proof of QSO. 3) Exchange must be on a ligitimate Amateur frequency. MARS and other services will not count. 4) DX entries may sumbit their application to a recognized contest log judge for verification rather than send proof with the application to A5. Domestic applications must submit proof of qualification to A5. Include sufficient return postage for registered mail, or your application will be returned without action. NET Contacts do not count!

Since it is anticipated that a grand achievement deserves a grand reward, A5 will go to special expense for the first award in each catagory. Unfortunately FCC regulation prohibit any contest which provides a substantial reward (ie a rig, Robot 800 or such) but we will provide one beautiful brass/wood plack (costs us about $100) for numero une, and the rest of you will have to be happy with flimsy paper awards like everybody else gives out. A photo of these will appear in an upcomming issue when the arrive at our offices. So, get on the air and start SSTVing. One final word, we will actually verify some of your contacts, randomly selected from your "evidence". We want to be sure that the person who really works hard at getting all ligitimate contacts necessary is the one getting the award. This will be some tough award to get, all the more reason to try and get one. If there is a dispute, you will be given an opportunity to provide additional information if required. A5 staff are not eligible for awards, but may provide contacts and an occasional DX-pedition will be made if there are no known stations operating from a particular state. Yeah, I know its hard to get Delaware, Wyoming, Idaho and such. A5 operated from Wyoming over the Labor day weekend. If you missed it, YOU MISSED IT! Generally KB9FO can be found on 20 and occasionally 10, but while there is a 4 element monobander on 20, there is onyl a vertical on 10 at the A5 shack and my real life job takes me all over the country so I'm not on all that much.

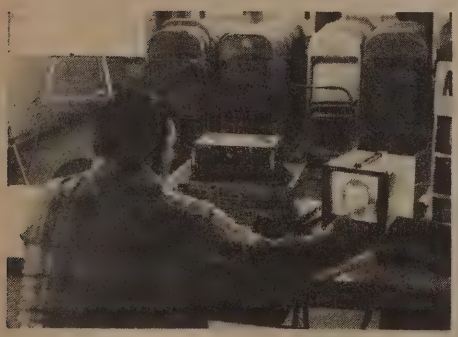
Peoria will go down as one of the better hamfests. Thanks to Mike WBØQCD and Don W9NTP who helped with the ATV booth and fly-bys. There were live demos of P-7 SSTV, using two different systems, one commercial and one home brew, two Robot 400's, one of the new SC422 German SSTV converters, with live and taped video. Also, color FSTV from plane, ground and satellite TV, as well as live RTTY and computers. Medium scan was demonstrated by Don thanks to a great video tape show. The folks running the fest were top notch and the only sore point was the long lines for food, the caterer came with the fairgrounds and wasn't very efficient. A good turnout was ushered into the Opera House for the meetings and demosz. Photos below and on following page show some of the ACTION. Even found some bargains in the flea market which were worth taking home! We expect to be back next year. Cincinnati was reported to be really down, especially since the food was eliminated. One good fest down the drain. It seems the only good fest in Ohio is Dayton, where they used to have several really good ones. We had three years of bed vibes from Toledo and will never go back, and after considerable expense in going to Cincy a couple of years ago to specifically set up an operating SSTV station, only to run into unsurmountable problems with power/antenna/booth locations we will never go back to Cincy again either. That leaves Findlay, Lima and Dayton. The problem with Dayton is the group is getting greedy. It wasn't long ago when a booth was $75, then it went to $100, then up and up. I suspect by 1982 it will no longer be economically profitable to go to Dayton as a Commercial exhibitor. Since we make a grand total of about 40¢ per subscription above the cost of printing, mailing to pay for ATV trips, advertising, we have had to rely on our book and personal gear sales to pay for the Dayton blow out. Since the books are almost gone, this revenue is gond also. Three days in the flea market will kill any normal human let alone us wierd folks who also stay up late talking about ATV, FM, the FCC and other topics (we all) enjoy. Usually I take monday off just to recover! RSO Convention in Ontario (Toronto this year) promises to be as good or better than ever. We look forward to their top notch show every year and really enjoy ourselves. This year my ATV talk was on repeaters now that everyone has discovered how easy DX ATV is.

Above – SC-422 TWO MEMORY TRICKS

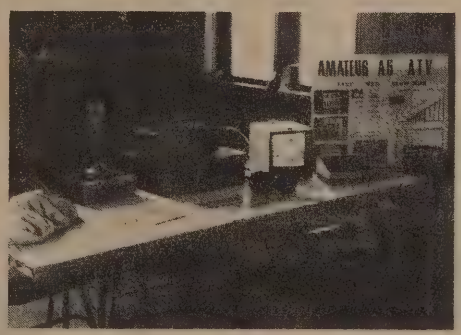
Smaller than a '400'.

Simple Controls

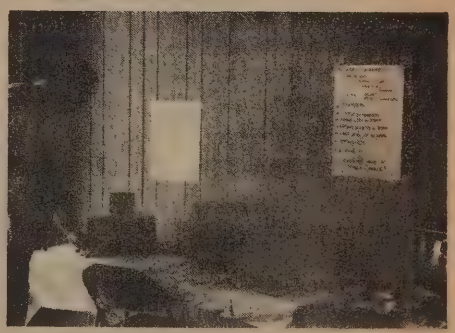
Keyboard Too!



Mike adjusts gear



One of three ATV tables



FSTV Demos & P7 SSTV

ARRL Director Don Miller W9NTP with ATV fly-by plane.

Keyboard Tricks

For Hams Only!

Fast Scan TV-SSTV
video
DX
A5 Amateur Television Magazine
Mike Stone, WBØQCD
P.O. Box H, Lowden, Iowa 52255

W1AW DX BULLETIN SCHEDULE

SSB - 0130/0430Z Friday (Thursday PM USA)
CW - 0000/0300Z Friday (Thursday PM USA)
RTTY - 0100Z Friday (Thursday PM USA)

SSB 1835 3990 7290 14290 21390 28590 kHz
CW 1835 3580 7080 14080 21080 28080 kHz
RTTY 3625 7095 14095 21095 28095 kHz
CW 18 wpm - RTTY 60 wpm/170 Hz

DX information courtesy SNEDXA.

SSTV Amateur Television

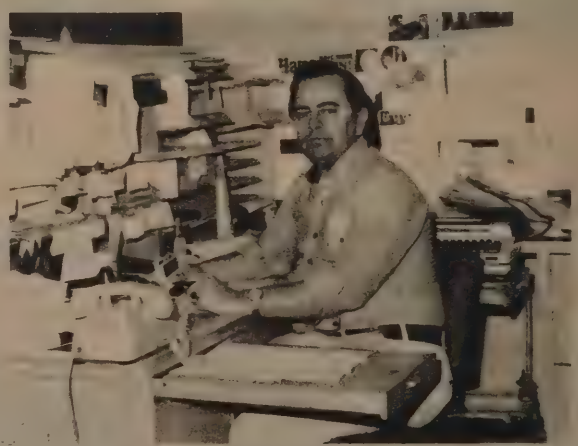
David Guthrie, 5NØDOG (K4QX) operating in Lagos, Nigeria-Africa is announced A5 Magazine's SSTV DX'er of the year for 1980! Congratulations Dave. Dave devotes "hours" of operating time on all bands and can be found mostly on Rtty, SSTV and SSB (including some CW) to attribute his well rounded all-mode capability. In case any of you have worked him but have not received a QSL, his stateside QSL manager is W4FRU, John Parrott, 4640 Oceanview Avenue, Virginia Beach, VA.-23455 (Send SASE). 1st Chilean SSTV station CE3AUL, Santiago is now on the air! Nick's recent purchase of a Robot 400 converter from Florida puts him right up there for quality transmissions. CE3AUL, as ARTS Director for Chile, South America handled phone patch traffic for relatives here in the states and is procuring a camera for "live" 3rd party traffic relays within the ARTS TV network. CE3AUL can be found on 10 and 15 meters. Bragging about how I was coming along with my attempt at the WAS-SSTV Award by A5 Magazine, W1WS directed me to an old 1975 issue (March) of QST Magazine where she was written about as being the 1st YL to work-all-states on SSTV! How's that for Womens Lib? KA1FJ's "horse hockey" comments in a recent issue of QST brought several "rebuttal" letters on behalf of SSTV'ers. Go get em' fellas! ZS6BTD-Gerald in South Africa now has 3 Robot 400's and the fabulous German SC-422 for a total of 5 memories. Can WA7WOD top that? HS1WR now active on twenty from Thailand, ZL1BLV still working many stateside stations on .680, WA8YJE-Dwayne in Michigan reports good activity on 15 meter SSTV and worked OZ5DV for 2 hours! Ten Meter SSTV-DX has been running earlier than normal in openings (based on the past few years) and is beginning to open into six-land from the midwest. By printing time, Ten should be in full swing, try it-you'll like it! WA1TPC worked I3BQC, LU4DGN (and other Argentina novices) are at 28.920 Mhz. looking for SSTV, WB9MCF and W1GUC joined MARS-SSTV, AI1Z now on the air from Rhode Island on ten-meters for a "rare" stateside contact, WBØYUI and WDØAYT and Clinton, Iowa ARC are getting set for DX-pedition to an island in the Mississippi (SSTV details elsewhere), ZD8KG is still "dodging" sharks between SSTV transmissions. July 17th proved a fantasticly strong opening for AG8O, QCD, N8AEP, W1GUC and N4VT for over four-hours! VE6AZM-I need your address for returned 10 Meter Net Certificate. WD4FHB now KC4CK, N9AEP "Tracy" on SSTV as is his Ohio counter part N8AEP-Bob, WBØKFB and WBØTTR worked LU4DGN and ZL1BLV with TTR also working CE3AUL on ten. Send SSTV-DXCC letters of support to W4UG and W3AZD c/o ARRL, Newington, Conn. 06111. (Now)

Tune in tomorrow

Approval of FCC Docket 80-252 nears (SSTV A5/FAX A4 General Class Bands HF) for possible fall approval. Many of you have commented with the suggested SSTV CQ calling frequencies and operating ranges:

Meters	Advanced	General+	Operating Ranges
10	28.680*	28.680*	28.680-28.690 Mhz.*
15	21.340	21.340	21.340-21.450 Mhz.
20	14.230	14.340	14.340-14.350 Mhz.
40	7.171	7.290	7.290--7.300 Mhz.
80	3.845	3.990	3.990--4.000 Mhz.

The general idea being to "fight" for the top-end of each band segment. Send your comments!



Don Search, W3AZD, at the ARRL DXCC desk.

SEND CONTEST LOGS TO: MIKE STONE WBØQCD, BOX H, LOWDEN, IOWA. ALL ENTRIES MUST BE RECEIVED BY JANUARY 30 TH 1981.. WINNERS WILL BE ANNOUNCED IN FIRST AVAILABLE ISSUE OF A5.

The most important thing to remember as we struggle to obtain recognition at the various locations on the HF bands, is to present our mode of operation as we have on presently used SSTV frequencies; tactfully and pointing out to our SSB "brothers" that SSTV A5 emissions are legal to run any where in the phone portion of the bands, but that SSTV'ers limit themselves to just a few KC's of operation-so not to cause QRM interference to others. Amateur's have been recognized as "self-policying" and many times gets us extra privledges that other services do not enjoy. It is hoped that in time, the new frequencies could be used by all classes of licenses and perhaps some failing established frequencies could be given up and a very strong united "foothold" could be obtained on the top end segments. The only question that seems to remain unanswered, is on ten meters where Generals already dominate and have well established their "mode" in a crowded spectrum. *Some suggest we take 28.990-29.000 Mhz. allowing us to avoid certain confrontations in a growing SSB/DX area and again establish a "top end" segment yet not that far removed from established SSTV calling frequencies. Some DX stations in foreign countries are not allowed below 29 Mhz. for A5 transmissions in some classes of licenses which would more than welcome a "higher" frequency. Operators who have worked higher frequencies know that when ten-meters is open-the higher frequencies are as good as the lower ones with less QRM. Pse voice your opinion and comments on this matter as we should have this agreed upon by the fall.

FAX

Facsimile (FAX) has been termed "Poor man's Slow-Scan" and is similar in techniques and transmission. It is the sending of still pictures via a radio relay. With the approval of FAX being "tacked" on to FCC 80-252 on recomendation from Robert J. Roehrig (RM-3239), certainly it will be the Slow-Scanners who will populate the HF bands with FAX. Many of us "played" with the A4 emission and equipment long before getting into SSTV. A combined SSTV-FAX operating area would certainly seem beneficial to both groups. Perhaps one of you "FAX" experts could volunteer some articles to A5 Magazine? (Better buy up those cheap Western Union Deskfax units at hamfests!) I can see it now, ROBOT FAX Keyboards! "Where does it all end?"

T.V. Mailbag

WA4OAA and WA7WOD have TRS-80 SSTV-graphic computer programs available-send good cassette and mailing reimbursements. WB1ARZ is offerring demonstrations of his new SC-422 converter, WBØKFB Jim in Cedar Rapids, Iowa has some neat idea/plans for an SSTV "art easel", WB9MCF-Ron in Illinois says "light-dimmer" switches work well for better control of shading on camera aligned pictures, K6AEP has mastered the SWTP-6800 system for full SSTV two-way pictures without need of a converter! Dan Mahoney, 8 Arlington St, Auburn, Mass.-01501 (617-755-9316) is looking for a schematic of a 100 watt UHF television transmitter that will operate between 400-806 Mhz., WB4APR-Bob Bruninga of Vienna, Virginia working with Rtty and SSTV for the deaf, W9FHB has a simple IC circuit for foolproof SSTV sync tuning, Color Cameras (RCA) are going for under $400.00 out on the west coast, WB9UCW says "see you all at the Peoria Superfest" (Sept. 20/21) A5 there! Schedule for Peoria "Superfest"-Friday afternoon/evening A5 booth setup (beer bust)-ATV'ers staying at "Days Inn I-74", Saturday-10 am. Color FSTV Fly-by in Cessna 150 by KB9FO, 1pm.-SSTV forumn, Color SSTV by W9NTP, 2 pm. MSTV, 2:30-FSTV by KB9FO, 3 pm.-Satellite TV-live ATV Amateur and Navy-MARS SSTV Station operating! A5 Staff will be there...come on down!!!!!!!!!

Fast Scan TV

AG8Ø-Larry in Ohio and W6NJZ/Ø in Lanagan, Missouri building FSTV systems. WB6ZPN joined ARTS for Fast Scan work. WA6EVQ-S. California ATV Club had a T-hunt (Thad) avionic style and also got a tour of Glen Daly's Color Studio in Huntington Beach. W5DFU and WB5LUA set a new record for ATV (Oklahoma to Texas) 215 miles DX on April 3rd at 0625 GMT on 426 Mhz. ON 280 MW. Rf! N7AOU has the whole neighborhood watching his ATV activity...Rumors of a new ATV repeater in the Tucson, Arizona area-crossband 438/1265 Mhz. and dogfights air-borne style with ATV over Los Vegas? WA6SVT/R at 5,900 feet (Mt. Wilson) was used for the annual "Tournament of Roses" Parade. Send reports!

Fast Scan TV-SSTV
video DX
A5 Amateur Television Magazine
Mike Stone, WBØQCD
P.O. Box H, Lowden, Iowa 52255

YEAR END REPORT January's propagation on the popular 10 meter segment was in full swing with stateside contacts openings that you could set your 24 hour clock by. Six land was peaking in the afternoons and well into the night hours, ZL and VK land was in by early evening with JA's common by Johnny Carson time. Mornings and the sun-rise brought in Europe and Africa with South America noticably missing. Central America and Mexico was in regular by March with Argentina TV stations starting to come in by mid-April. DX began to dwindle with only occasional rapid openings thru June and parts of July. Europe was gone for July/August (Midwest and West Coast) until mid-August. During the eastern-lull, South America shined including Chile, Uruguay, Argentina & Venezula. South America's disappearance in the fall 1980 is a real mystery? Anybody working them? Stateside Six-land returned around September 4th with accompanying JA's following in October.

The very noticeable comparison about 1980 "fall-winter" SSTV DX season is that compared to the previous year's propagation at the same time, everything is "happening" quicker! All areas are about two-months ahead of schedule. A good winter 1980/1981 season is expected as the sun-spot cycle period declines. Twenty-meter SSTV pretty much held as usual and along the same pattern of openings. With the expected opening of SSTV mode for Generals in the HF bands, a stronger & more organized "hold" of the SSTV operating frequencies should improve if all will unite at the top end of the band. A comparison chart is being prepared of DX propagation thru the past few years which will appear in the next issue. Send your DX reports and contacts! 28.680 Mhz. got off to a good start for the fall-winter DX season on Sept. 14th as Europe and Africa opened up with G3NOX-Jeremy and Color SSTV experimentations with W7KPW and WA7WOD, ON6UX-Ruddy in Temse homebrewing his own Robot 400 type converter, OJ1IW-Rudi in Kahl, Germany along with other German SSTV'ers such as DL8AC, DK7RZ, DL1CD, OZ4KK and OZ2YKK sending nice video also. Chile's 1st SSTV station active in many years-CE3AUL-Nick in Santiago gave many US operators new country addition. Even ZL2FR worked Nick for a "rare" down-under contact. CE3AUL has been exchanging medical X-RAY pictures via SSTV with a friend in Orlando, Florida and your's truly. The pictures came out so good that Nick (a doctor) could even see hair-line breaks in one foot). (2nd opinons on A5?) Iowa SSTV'er WDØEZK reports 130 Countries, WBØWKQ at 53, WBØQCD at 43 and holding. (WBØWKQ worked 45 Countries in one fun-weekend!) Your's truly hit my long awaited 1,000 SSTV QSO's mark on 10 Meter band (all under 50 watts) so Henry get an endorsement ready for my "Master Scanner" award! ZF1HJ in the West Indies (Cayman Island) is active now using Robot 400/800 combo with ZF1GC working on Rtty mostly. Jack's first contacts were OH5RM, K1DMU, WBØQCD, XE1AAK, WBØTTR, WBØUNB and AI4A. The video "cross" is the symbol for DJ1IJ-Hans who runs SSTV when not giving Mass at his catholic church! Father "Hans" has 138 countries to his credit on Rtty and 25 on SSTV. Others to work the "Father of SSTV" were KA6BRT, WA1ARZ and WBØWKQ. W7AMQ worked W7KPW on OSCAR 8-SSTV May 10th 79 at 0500 GMT on orbit #6005. Anybody else working VHF Satellites? What frequency are you guys at? With the dropping in retails of the popular 400 converter and the competition from Volker Wraase SC422 system, it doesn't seem long before a new 500 model appears with several memories and ready for Color? ZS6BTD holds the record so far with 5 memory capability (3 Robots 1-SC422) and send-Color SSTV. W7KPW working G3NOX one way transmit color using Kodak lens filters and his Robot 80 camera. Jeremy is taking photos of incoming video and sending it back in the mail as QSL. Color information in past A5's. Apologies to WBØKFB in Cedar Rapids, Iowa as the "SSTV Tuning Article using a 567 IC Chip" that appeared in Sept/Oct issue ran early before Jim made production on the pictured boards. Can anyone make some of those boards? 5N2ØDOG-Dave got permission for the very special event station call from the Nigerian government as the country celebrates its' 20th year of independence. Those that worked Dave (1980 SSTV'er of the year) got a unique QSL card confirming the contact. ZS6AF-Julias in Johannsburg reports that there are now 10 Robot 800's there! (That's why there is a waiting list!) WB1ARZ became the 3rd owner of the 2-memory 16K German SC-422/KB422 system. ZD8KG-Kent is moving from Ascencion Island in November to the Bahamas. Look for him around the first of the year on 10 meters. A "rare" CX2AB-Frank is calling CQ from down in Montevideio, Uruguay with his Robot 400 while Chile boasts 3 stations; CE3AUL, CE3BGE & CE3AQX.

TI2SW very active on 10 meters, ZL2FR is on the band most every evening comin into the midwest around 7 pm. until 11 or so. W1JKF-Brooks holding together the successful 20 Meter SSTV Net as he admits that his memory is failing. He went down to the bookstore and bought one of those "How to Improve Your Memory" guides but when he got home-he forgot where he laid it! The 10 Meter SSTV Net is in full swing on Saturdays at 2 pm. CDT. Working on WAS/SSTV for the A5 Magizine Certificate Award? Watch for Alaskan SSTV station KL7HD and Hawaiian SSTV'er KH6SB on 28.680 Mhz. Who has WAS on SSTV? Submit log certification copies or listing of stations worked to KB9FO c/o A5 Magazine for Certificate. The Peoria, Ill. "Superfest" went great with Henry Ruh and Don Miller attending. Color and Medium-Scan as well as a Airborne FSTV show was presented to the thousands of "hams" who attended. Next ATV/SSTV show will be at the February Davenport, Iowa Ham-fest. Video tapes of the Peoria Fly-by, SSTV/Color SSTV & Medium Scan will be presented. Live FSTV ATV will be aboard with the station of WB9CKS transmitting from the hamfest!--All SSTV/ATV'ers make it! Prior evening get together and--dinner. Make reservations at the Quality Motor Inn. More--information to follow in next issue. See you there! Look-for Novice-grade SSTV'ers from Argentina above 29 mcs. The most active station in Argentina is LU4DGN-Charlie. Charlie says "talk-slow" and send "lots of video!" ZS6BQT somehow got the reputation for liking girly pictures and his wife--caught wind of it and designed an X-Rated filter for the --front of his monitor.... NNNØICE (Navy MARS SSTV Station) reports a strange happenning in December as a frame of SSTV "video" got released into the cold frigid air and "froze" and never got to its' intended destination. (WBØWKQ believes it?) As I sit here at 6:51 am. Saturday morning typing this column I hear ZS6PP working a german on .680. (KB9FO still wondering how he won two free tickets to the Davenport Hamfest?) SSTV'er and long time ATV nut Don Miller W9NTP of Waldron, Indiana won 1st prize (Drake TR7?) at the Peoria, IL. "Superfest". Next time you hear ZS6PP-ask him how he melts the "butter" for his XYL? (Linear). Congratulations to N6AZV-Bob Kneebone-Long Beach, Calf. winner of A5 CROSSWORDS CONTEST!

TO
OMUC
HDXINGCANB
edangeroustoy
ourfamilylifeandhealth

FACSIMILE (FAX) Those strange syncing sounds that appear on 28.680 Mhz. from time to time are coming from SSTV'er JA2DYI calling CQ-FAX. (FAX is illegal in the US HF Bands at present). As the request for FAX A4 operation is considered by the FCC on the HF US Bands-Contacts are being made in foreign countries. Japanese FAX stations have to hold special licenses to operate F4 modes for 10-80 meters. Some standards used and equipment that is popular over there are; Converted IBM machines or Toshiba units-Drum size 68.5 mm (8X11 paper), 3.85 Scanning density, 120-180 RPM speed of drum, 264 factor of cooperation (lines) FS/SSB modulation (audio mic. injection) 1500 hz. black, 2300 hz. white. It certainly will be the SSTV'ers who will pick up the mode when it becomes available. A5 Magazine needs FAX articles, send some!

Fast Scan TV

ZS6PP-Pete in South Africa is clearing the way for other African ATV'ers for transmission of FSTV as he requested from the government for permission to use the mode between other Amateurs at 439 and 1260 Mhz. In Africa the broadcast commercial TV band is 40-50 Mhz. AG8O in Ohio is almost finshed with his homebrew version for FSTV and will begin testing soon. W9RI sent a 6 watt test video-carrier from Rock Island, Ill. and was seen 40 miles away. WB9CKS Ed in Streator, Ill. seaches in the evening for Indiana & Chicago stations at 439.25 Mhz. WBØKFB in Cedar Rapids is selling one of his trucks to get some money for the Science Workshop model FSTV unit and will be on shortly. Jim built his own 439 colinear design from the ATV IN A NUTSHELL A5 MAGAZINE handbook. I need to get some ATV VHS Tapes 2-4-6 Hour format with "live" QSO's showing several ATV'ers chewing the rag with COLOR and mobile and repeater operation. Can you help? I'll send the price of a tape and mailing to someone who can do this for me. Send reports of your ATV activities and DX'ing! Good Video!

Amateur Television Magazine

DEVOTED TO HAM TV

INTERNATIONAL SSTV CONTEST

CONTEST DATES: JANUARY 17th & 18th, 1981
CONTEST TIMES: 1500 UTC (17th) to 0300 UTC (18th)

36 hours

U.S. EDT 9AM till 9PM (SUNDAY)
CDT 8AM till 8PM "
MDT 7AM till 7PM "
PDT 6AM till 6PM "

"In the true spirit of friendship via Amateur Radio, A5 Magazine presents a fresh and unique new approach to contesting-the way all contests should be." A simple 36 hour contest period (no rush and plan your own operating times) designed for "quality" not necessarily quantity. Study the rules and let us know how you did. The top five scorers will receive one years free subscription to A5 Magazine with the winner also receiving a brass plaque to be awarded officially at 1981 Dayton Hamvention by Awards Mgr.

-Rules and Guidelines-

1. Frequency band segments:

Band	Call	Window	Spread
80 Meters	3.845 Mhz.	3.835-3.855 Mhz.	20 KCS
40 Meters	7.220 Mhz.	7.210-7.230 Mhz.	20 KCS
20 Meters	14.230 Mhz.	14.220--.240 Mhz.	20 KCS
10 Meters	28.680 Mhz.	28.670--.700 Mhz.	30 KCS
6 Meters	50.200 Mhz.	50.200--.220 Mhz.	20 KCS
2 Meters	*146.430 Mhz. FM		
	*144.230 Mhz. SSB	*or local option	

2. Only two-way video exchanges count. Callsign and RSV report must be on video. Each new contact is 10 points.

3. BONUS POINTS: Bonus points may be taken for the following additional video and contact options-

5 points for self-picture (mugshot) sent per contact(and QSL'd).
5 points for station setup or equipment pictures sent (QSL'd).
10 points for each state worked (US) 1 contact per state.
50 points for completion of WAS/SSTV contest (50 states).
25 points for each new country (DX) worked.
10 points for each Canadian province worked.
25 points for real 256 pixel by 256 lines transmission or 128 ½ sp.
100 points for Color SSTV two-way---50 points one-way received.
50 points for subscriber or new subscriber to A-5 MAGAZINE

This contest is designed for the all-around capability SSTV operator. It awards those who by camera or tape send other than callsign information. It has a longer operating period for those who work different times of the day. It provides a more relaxed atmosphere for qso'ing and avoids the usual QRM'ing for the sake of getting the most contacts. It promotes SSTV on bands not usually established for A5 operation. This contest rewards those who have experimented and can operate special mode formats within the Slow-Scan Television emissions.

Send contest logsheets (SASE for return) to Contest Manager, c/o
MIKE STONE WBØQCD
BOX H
LOWDEN, IOWA 52255
no later than January 30th, 1981

Amateur Television
SLOW SCAN TV

Amateur Television Magazine

DATE ON/OFF	FREQ. BAND	QSO NR.	(GMT) TIME	STATION WORKED			DATE ON/OFF	FREQ. BAND	QSO NR.	(GMT) TIME	STATION WORKED		QTH
		001							051				
		002							052				
		003							053				
		004							054				
		005							055				
		006							056				
		007							057				
		008							058				
		009							059				
		010							060				
		011							061				
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		038							088				
		039							089				
		040							090				
		041							091				
		042							092				
		043							093				
		044							094				
		045							095				
		046							096				
		047							097				
		048							098				
		049							099				
		050							100				

NOTE: The same station may be worked once on each band.

SCORING: Total number of QSOs _____

Total time of operation _____

POINT TABLE

FINAL SCORE

STATES ___ PROV. ___ COUNTRIES ___ CONTINENTS ___ MUGSHOTS ___

6/2 VHF SSTV ___

SIGNATURE _____ CALL _____ QTH _____

DATE ON/OFF	FREQ. BAND	QSO NR.	(GMT) TIME	STATION WORKED	10	BONUS	DATE ON/OFF	FREQ. BAND	QSO NR.	(GMT) TIME	STATION WORKED	10	BONUS
		1							51				
		2							2				
		3							3				
		4							4				
		5							5				
		6							6				
		7							7				
		8							8				
		9							9				
		10							60				
		1							1				
		2							2				
		3							3				
		4							4				
		5							5				
		6							6				
		7							7				
		8							8				
		9							9				
		20							70				
		1							1				
		2							2				
		3							3				
		4							4				
		5							5				
		6							6				
		7							7				
		8							8				
		9							9				
		30							80				
		1							1				
		2							2				
		3							3				
		4							4				
		5							5				
		6							6				
		7							7				
		8							8				
		9							9				
		40							90				
		1							1				
		2							2				
		3							3				
		4							4				
		5							5				
		6							6				
		7							7				
		8							8				
		9							9				
		50							100				

MAKE COPIES

NOTE: The same station may be worked once on each band.

SCORING: Total number of QSOs _____ X 10

Total time of operation _____.

Amateur Television Magazine

= _____ + BONUS _____ = TOTAL

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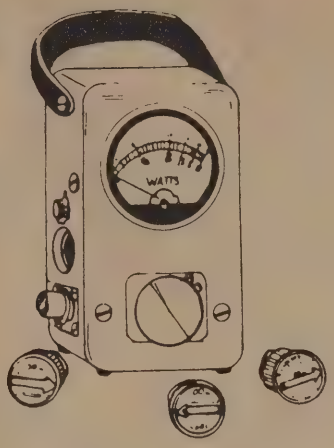

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ORDER NOW!

Have you ever tried to get "back issues" of A5 Magazine? Once they are published and mailed-they become collectors' items! Issues are now on file at the permanent archives at the U. S. Library of Congress. Arrangements have been made with WBØFSF Ralph Wilson, 4011 Clearview Drive, Cedar Falls, Iowa-50613 to make copies of articles requested and entire copies of each issue as they are published. 1979-1980 articles and issues are now available. We will be adding to "Reds" listings as time goes on. The following is a listing of articles published for the last year which will become a regular item in the November/December issue at the end of each year.

While checking the subscriptions for the Post Office forms we have to fill out each year, we came upon the following statistics. Total subscribers, 1400. 52 DX, 72 Canada and the rest US. Of the 27 DX countries which receive ATV Magazine, Australis leads with 11 subscribers. Spain and England each have 4, South Africa 3, Argentina, France, Germany, Japan, Jordan, Mexico and Venezuela each have 2, and Burmuda, Columbia, Denmark, Finland, Hong Kong, Ireland, Italy, Israel, Netherlands, New Guinea, New Zeland, Norway, Portugal, Scotland, Sweden and Switzerland have one each. In Canada it breaks out as VO-1, 1, VE-1 8, VE2 11, VE3 43, VE4 1, VE5 1, VE6, 9, VE7 2.
The map below shows the US distribution. The biggest, by almost 3:1 is California with 203 copies, followed by New York 77, Pennsylvania 76, Ohio 73, Illinois 67, Indiana 66, New Jersey 61, Florida 50, Iowa 42, Massachusettes 40, Texas 38, Virginia 39, Michigan 41, and the rest of the bunch. We have at least one subscriber in every state thanks to hardy folks in S. Dakota and Wyoming. The earliest listing of this info I could find in the archives is in the July 73 issue and is shown on the second map. which I listed 589 stations. I don't know if all were subscribers at the time or not. From info I have been able to gather, one out of four ATV'ers (all modes) subscribes to A5. So we would estimate that there are 5600 ATV'ers in the US (give or take a few thousand.

Argentina	2	Jordan	2		
Australia	11	Mexico	2	CANADA VO 1	1
Bermuda	1	Netherlands	1	VE 1	8
Columbia	1	New Guinea	1	VE 2	11
Denmark	1	New Zeland	1	VE 3	43
England	4	Norway	1	VE 4	1
Finland	1	Portugal	1	VE 5	1
France	2	Scotland	1	VE 6	9
Germany	2	Spain	4	VE 7	2
Hong Kong	1	South Africa	3		
Ireland	1	Sweden	1		
Israel	1	Switzerland	1		
Italy	1	Venezuela	2		
Japan	2				

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EDITOR *(Name and Address)*
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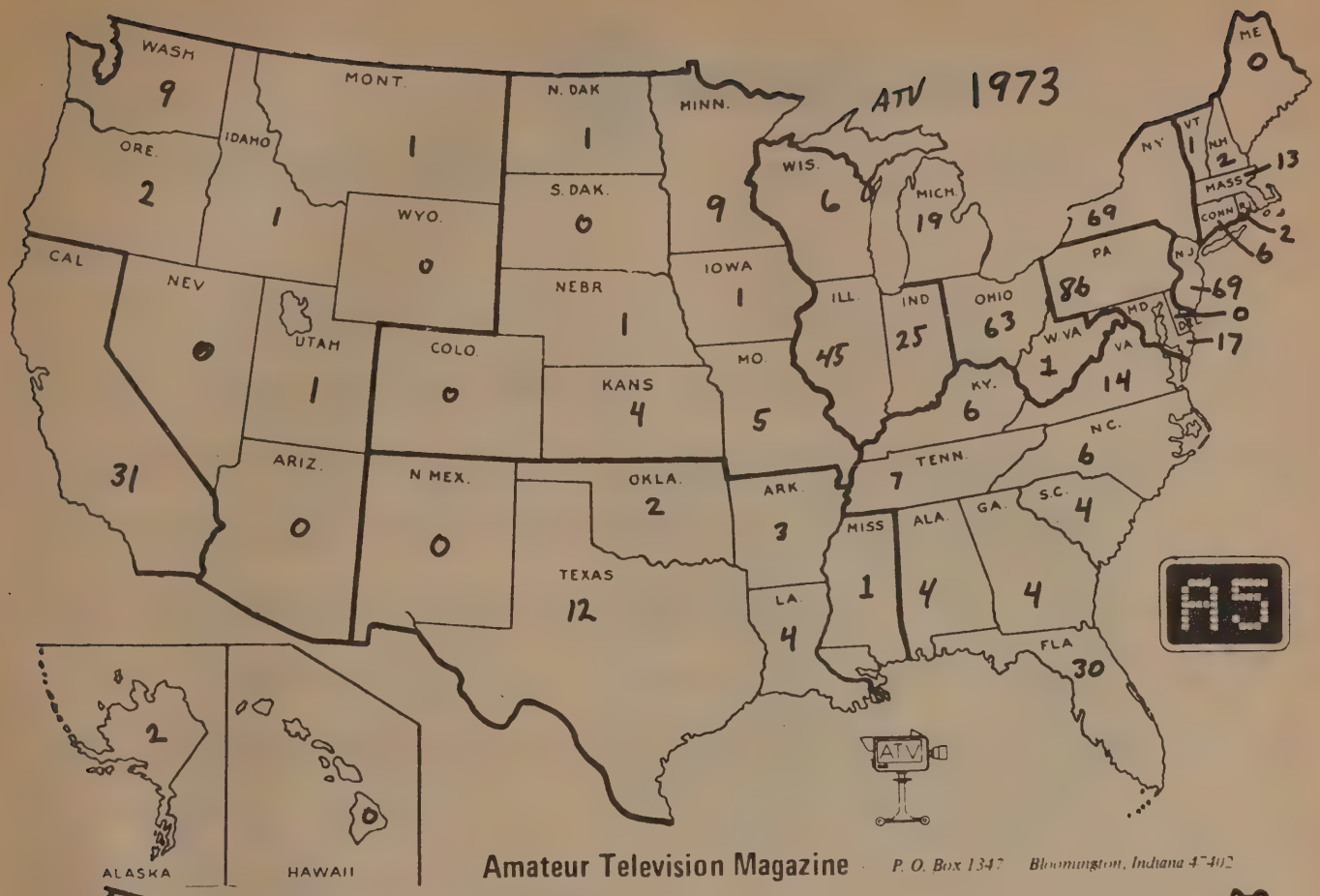

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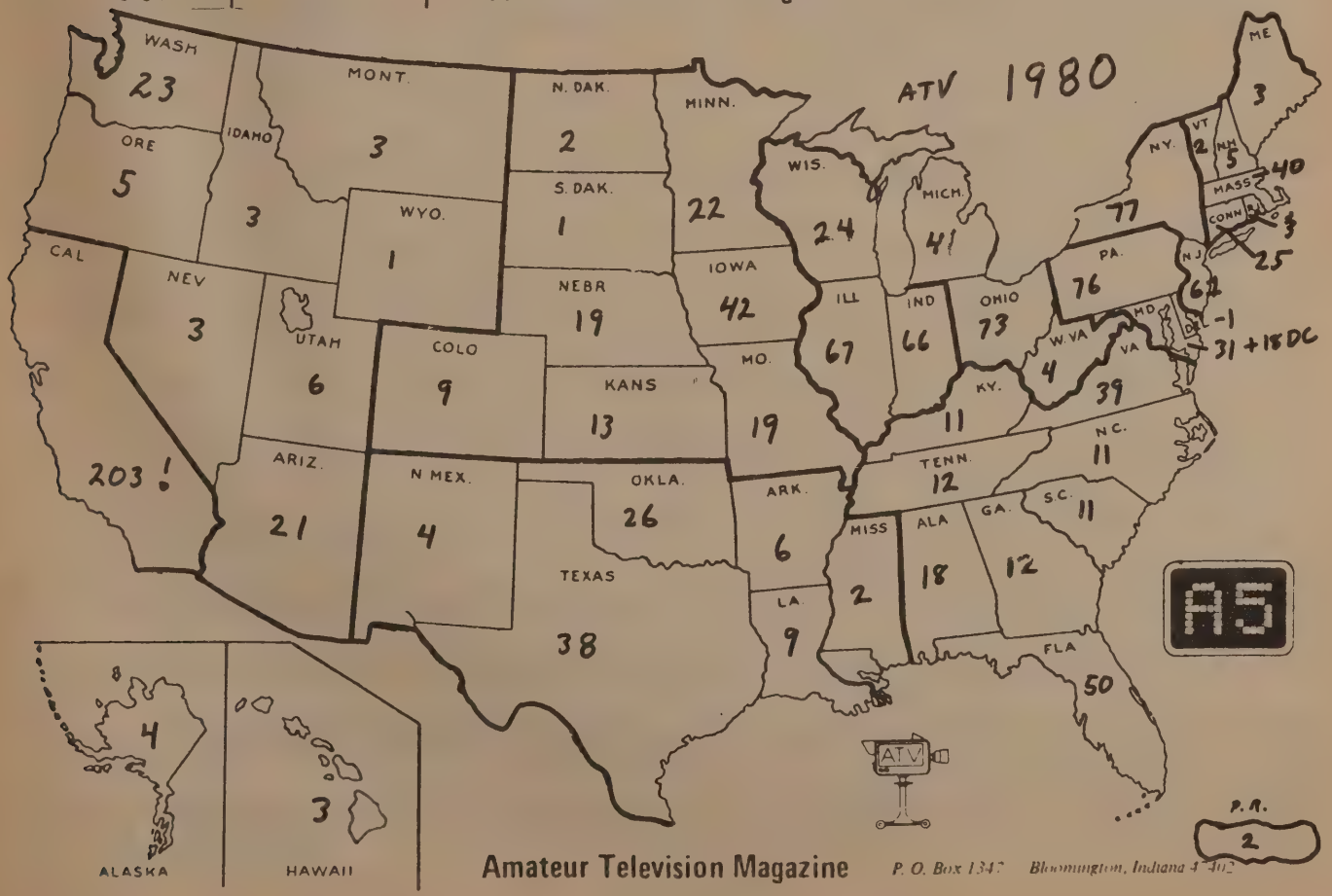

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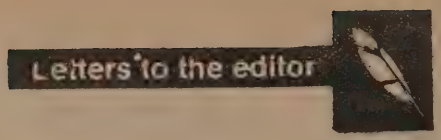


Rebuttal to W2NSD/1 "Wayne Green" editorial 73 Magazine - Sept. issue

"Dear Wayne"

In our exchange of correspondence on various issues within the past years, you have always mentioned as in your most recent comment in the Sept. issue of 73 Magazine, that SSTV suffers from the same problem as commercial television-poor programming. According to your view, the enthusiasm "blows over" in a few months of operating the specialized mode of Amateur Radio and even gets "boring" waiting for the 8 second pictures to paint on the screen. Although you-to your credit-continue on to give some positive ways of "improving" Amateur SSTV (as well as sponsor the March SSTV Contest by K4TWJ), I suggest that perhaps you have been toowrapped up in your publication and detective seeking attacks on the "League" to really know what is going on with SSTV on-the-bands?

Have you monitored or fired up a converter recently? I just don't see how you have come to these conclusions with all that has been happening within the A5 mode of recent. I entered SSTV only a year ago last June and have just short of 1,000 contacts ON JUST TEN METERS! I followed the path that others have in the past starting out with a converter and tape recorder, then buying a camera and eventually one of "pits" graphic-keyboards. I have found just sending my photo is never enough in an exchange with my fellow contact. Half of the fun for us ATV'ers is the making of the programs to be used! I have seen everything from family, shacks, gear, houses, city and countryside views, SSTV-ART that covers everything from closeups of dollar-bills to handmade drawings. I saw ZS6BQT kiss his lovely wife in his South African home, G3WW send ariel views of his house in England from a helicopter, 5NØDOG shooting "live" out his window in Nigeria filming a young native girl carrying a bamboo basket on her head, CE3AUL in Chile exchanging medical X-ray pictures with a fellow SSTV'er in Orlando, Florida, G3NOX transmitting COLOR SSTV, WB5UDU hand-drawing cartoons to match his trend of conversation, W6VIO at the Jet Propulsion Lab relaying live pictures as they came in to NASA of Voyager's journey by Saturn, tic-tac-toe games with LU4DGN in Argentina, photo's of Mt. St. Helens eruption before the released photos were available by the press via W7AWQ, computerized SSTV generation by K6AEP and SWTP-6800, etc. etc. "What boring programming are you talking about?" (Ed. Note: We use to send a copy of A5 to 73 but Wayne told us TV passe' so we stopped sending them copies) CQ, QST, HR and World Radio as well as other TV mags get copies.

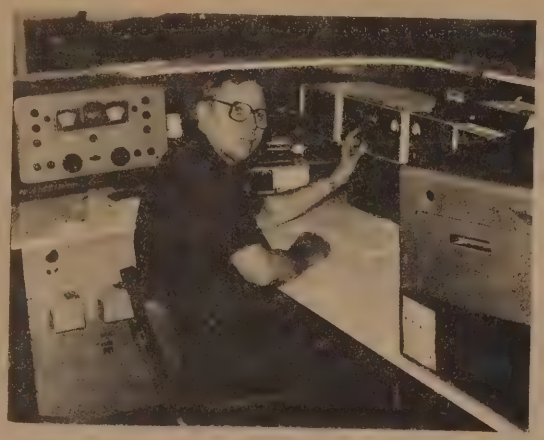
Do you subscribe to A5 Magazine to see what is happening in the A5 world? Were you walking around at Dayton Ohio for the last couple years looking at Volker Wraase's new 16K two-memory converter and graphic-on-video keyboard, or Don Miller's experiments with Color SSTV using two memories? Are you aware of the work being done by the "Amateur Radio Television Service" ARTS in the exchanging of pictures via SSTV for the military services? Yes-military SSTV such as US Navy MARS SSTV that began exchanging SSTV pictures 8 years ago into ships-at-sea and remote places such as Mc Murdo base in the Antarctic and continues today to hold several nets on 40 and 20 meters at varous times of the week. Being computer orintated, are you aware of the SSTV programs being passed around for the TRS-80's, Apples and SWTP-6800 series computers? Have you monitored or checked in to the weekly SSTV Nets on the weekends at 14.230 and 28.680?

Your PROM idea is interesting and don't have a heart attack but a high League official told me at a recent dinner that he "liked" your idea! But won't this boredom you refer to take over on such a device after a a few exchanges? I only suggest that you take that P-7 tube out of the closet and put some AC to it again and take another look! — WBØQCD LOWDEN-IOWA

W1AW FACELIFTING. As a result of preparation for the launch of the Phase Three OSCAR satellite and the introduction of ASCII bulletins to the W1AW schedule, the station underwent a major facelifting this summer.

Equipment that had been on several tables was consolidated into a new 9-foot formica-covered wood console. The left half of the console is the main visitor's operating position with a TS820S transceiver and 30L1 linear. A HAL DS3000 and ST6000 comprise the teletype and keyboard cw set-up. The right half, now that Phase 3 met its watery grave, contains the OSCAR 8 command station, general visitors OSCAR operating position for OSCARs 7 and 8 and future Phase 3 bulletins. An IC701 provides the 10-meter receiver, an IC251A, KLM 80 watt amplifier and a Tempo 2002 amplifier handles the 2-meter chores, while an ARCO linear with a yet to be acquired transceiver will be on 70-cm. A seven foot rack will contain the amplifiers and their power supplies. Wood-grain paneling was installed behind the new console to cover the cabling. The Collins console is now being overhauled and will soon be back in use, with a Robot 400 and SEEC keyboard, as the slow-scan and back-up visitor's operating position.

Chuck Bender, W1WPR, Chief Operator at the main console of W1AW.



The Editor,

Amateur Television Magazine,
P.O. Box 1347,
Bloomington,
Ind., 47402, U.S.A.

45 Ravnes Park Road,
Hampton, 3188
Victoria, Australia.

Recently I had the opportunity to holiday in the U.S.A. as guest of David WA6PKW and his lovely xyl Rachel, meeting personally and speaking on the tlelphone to many amateurs that I had come into contact with on SSB/SSTV.

Clay K6AEP very kindly drove me around the San Jose/Santa Clara area showing me many points of interest. My introduction to Ken KB6TL was in the H.R.O. store in Burlingame, his call was on the SSTV monitor in the shop and I inquired as to who belonged to the call, I was quickly introduced to Ken. Roland N6WQ came to visit me at the Hyatt Anaheim and drove me to his home where a pleasant night was had with his family and working back into Australia using Rolands equipment. The amateur guys in the Sparks/Reno area came en-masse to the Circus-Circus hotel where we all enjoyed meeting each other over many many drinks (was introduced to Wild Turkey).

My visit was far too short, three weeks and I did not get to meet all that I had hoped to meet but my next trip will be longer, six weeks minimum and hope to meet many more of the very friendly and hospitable U.S. amateur fraternity.

Did manage to visit the Robot Research establishment in San Diego and Mr. Joe Hawkins gave me an excellent guided tour of the premises, of course I saw the Robot 800 in production and immediately I knew that I had to have one of my own, now I do have it and my operating capabilities has now been extended to include also RTTY/ASCII and CW along with of course SSTV.

My station here in Melbourne has now been dismantled and soon will be commencing operations from New Zealand with my other call ZL2AAV, a call I have held since 1972.

Best 73's

Ralph

Ralph L. Cooper VK3JZ/ZL2AAV
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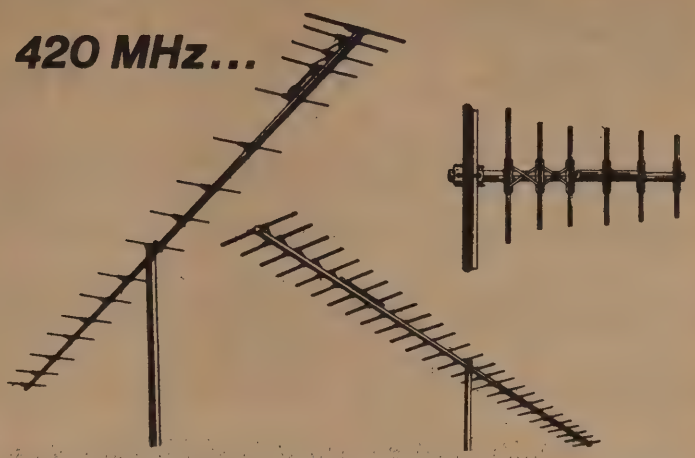

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PLANAR TRIODE TUBES FOR UHF AMATEUR SERVICE

Planar triodes (or lighthouse tubes) are well suited for amateur use in the UHF spectrum. Various surplus versions, such as the 2C40, 446B and 2C39 have been used at frequencies up to 1300 Mc. A new planar triode, the 3CX100A5 is now available for improved service in this frequency region.

The 3CX100A5 is relatively unknown to the amateur fraternity, but its older relative, the 2C39A, has been long a favorite UHF tube of the "surplus hounds". The 3CX100A5 is an improved, mod

has been long a favorite UHF tube of the "surplus hounds". The 3CX100A5 is an improved, modern version of this old World War II tube, dressed up in a brand-new ceramic and metal envelope. This tube, and its twin, the 7289 fit into the amateur picture very nicely as a straight-through amplifier, a doubler, or as a tripler in the frequency range of 1000 to 3000 Mc. In addition, it is not expensive, and various glass versions of the older 2C39/2C39A/2C39WA can often be obtained at give-away prices on the surplus market.

The following data covers grounded grid operation of the 3CX100A5 as a UHF power amplifier and multiplier. Because of the high power gain of the tube, grounded grid circuitry is desirable, since intercoupling between the input and output circuits is reduced to a minimum, and neutralization is not required. This data can be used to estimate the performance of the 2C39 glass family of tubes by noting that the useful power output of this style tube will be somewhat less (depending upon the frequency) by an amount up to 25-percent at 2.5 kMc as shown on the graphs.

Various 3CX100A5 tubes were run in a coaxial cavity capable of tuning from 1000 mc (1 kMc) to 3000 mc (3 kMc). A series of measurements was made using a representative sample of standard production tubes, with the tube under test operating as an amplifier, doubler and tripler. Drive and output power were carefully measured for each test, and appropriate filters were used to eliminate feedthrough and harmonic power. In the case of the amplifier configuration, the feedthrough power was useful output and therefore was measured as such. When the tube is operated as a doubler or tripler, the feedthrough power is at the driving frequency and is undesired. In actual use, it is necessary to eliminate this power from the output circuit of any grounded grid frequency multiplier. High-Q tuned circuits or wave filters will do the job.

The 3CX100A5 as a Grounded Grid Amplifier

A graph of average tube performance is shown in figure 2 of the UHF grounded grid amplifier circuit. Grid drive, grid bias, and plate loading were adjusted to provide maximum power output while maintaining the plate current at 100 ma. Average potentials for tubes tested are indicated on the graph. At 1300 mc, for example, the 3CX100A5 is capable of a power output of about 47 watts at an efficiency of 47%. The power gain of the tube is 8 decibels, indicating a required drive level of about 7.5 watts as measured at the input of the coaxial fitting to the cavity. Power output gradually decreases as the frequency of operation is raised. At 2400 Mc, power output

(at 100 watts input) drops to 25 watts, and grid driving power increases to 10 watts. Power gain at this frequency is 2.5. The comparative curve for the 2C39A tube over the same frequency range is shown by a dotted line on the graph.

The 3CX100A5 as a Grounded Grid Doubler

The same sample of tubes used in previous tests was used in performing the gain and power output measurements for the doubler configuration. Excitation was applied at half-frequency and the same precautions were followed as in the case of the amplifier. Test conditions were adjusted for maximum power output at a plate current of 100 ma. At 1300 Mc, power output is about 27 watts, with a circuit efficiency of 27%. Power gain is 5.4 decibels. Accordingly, a drive power of about 8 watts is required. At 2400 Mc, power output is 13 watts, with a drive power of about 9 watts. Power gain drops to unity at a frequency of about 2700 Mc. The tube is still useful as a frequency doubler to this frequency, however, as a power output of 10 watts can be obtained. 2C39A curve is shown as dotted line on the graph (figure 3).

The 3CX100A5 as a Grounded Grid Frequency Tripler

The same tubes and general test techniques were used to determine the operating parameters of this tube as a frequency tripler. Drive power was applied at one-third output frequency, and the circuit was adjusted for maximum power output. At 1300 Mc, 17 watts of power were obtained with about 10 watts driving power. At 2400 Mc, power output was about 8 watts, with about 12 watts drive power (figure 4).

Socket and Collets for the Planar Tubes

A complete socket for the 3CX100A5/2C39 type tube is a rare bird indeed: most equipments have the tube sockets built directly into r.f. cavities. Collet rings for the tube, however, may be bought from Instrument Specialties Co., Little Falls, N.J. The catalog numbers are: Plate collet, #97-70; grid collet, #97-72; cathode collet, #97-76; filament collet, #97-280. The Braun Tool & Instrument Co., 140 5th Avenue, Hawthorne, N.J. can supply the following: Plate collet, #134-53; grid collet, #134-51; cathode collet, #165; filament collet (none). A complete socket assembly may be purchased from Jettron Products, Inc., 56 Route 10, Hanover, N.J.

Conclusions

The planar triode tubes of the 3CX100A5 family perform well in the frequency range encompassing the 1215 Mc and 2400 Mc amateur bands. Efficiency is good, considering the frequency of operation. "Radio Engineering" by F.E. Terman indicates that a doubler will provide about 65% of the power output of a straight-through amplifier, and a frequency tripler will provide about 40% of the power output of the amplifier. These figures agree closely with the data shown herein. A pair of 3CX100A5's should make quite a dent in the 1215 Mc band! See you on the high end!

Robert I. Sutherland, W6UOV

Type	Manufacturer	Comment
2C39A	Eimac, Machlett	Glass or ceramic construction
2C39WA	"	"
6897	General Electric	Not interchangeable electrically in most high frequency sockets with 3CX100A5 or 7289
2C41	Machlett	Not interchangeable physically with 3CX100A5 or 7289
381	Eimac, Machlett	3CX100A5 type, rated for pulse service (Eimac-glass or ceramic)
3CX100A5	Eimac, Machlett General Electric	All ceramic construction
7289	Eimac, Machlett, General Electric	Identical to 3CX100A5
3CX100F5	Eimac	Identical to 3CX100A5 except heater voltage is 26.5 volts

Figure 1. Planar Triode Tubes

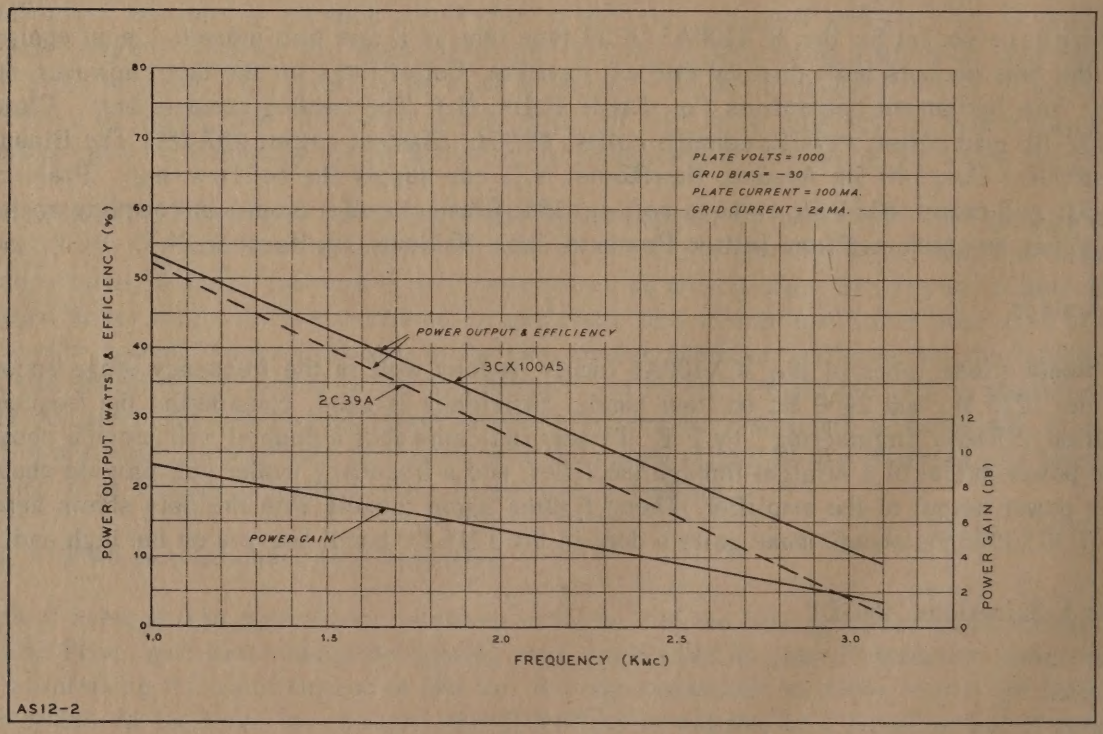

Figure 2. 3CX100A5 grounded grid amplifier; typical power output, gain and efficiency. Glass 2C39A power output shown by dashed line.

~~CHANNEL 15~~

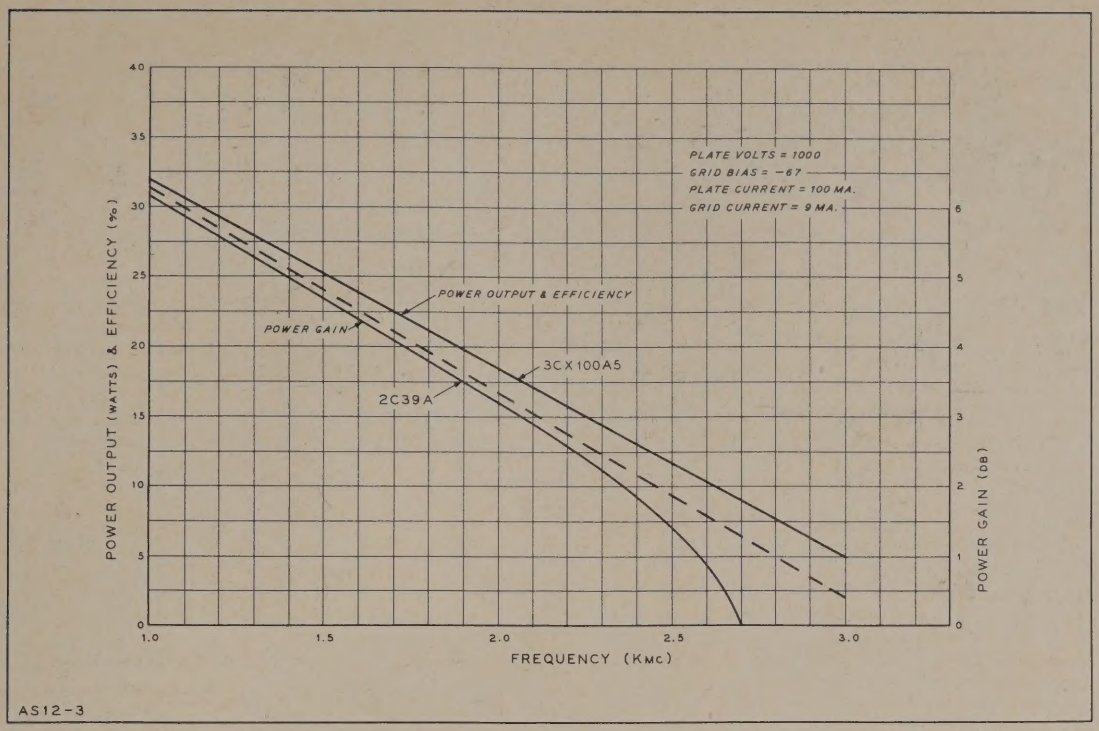

Figure 3. 3CX100A5 grounded grid doubler; typical power output, gain and efficiency. Glass 2C39A power output shown by dashed line.

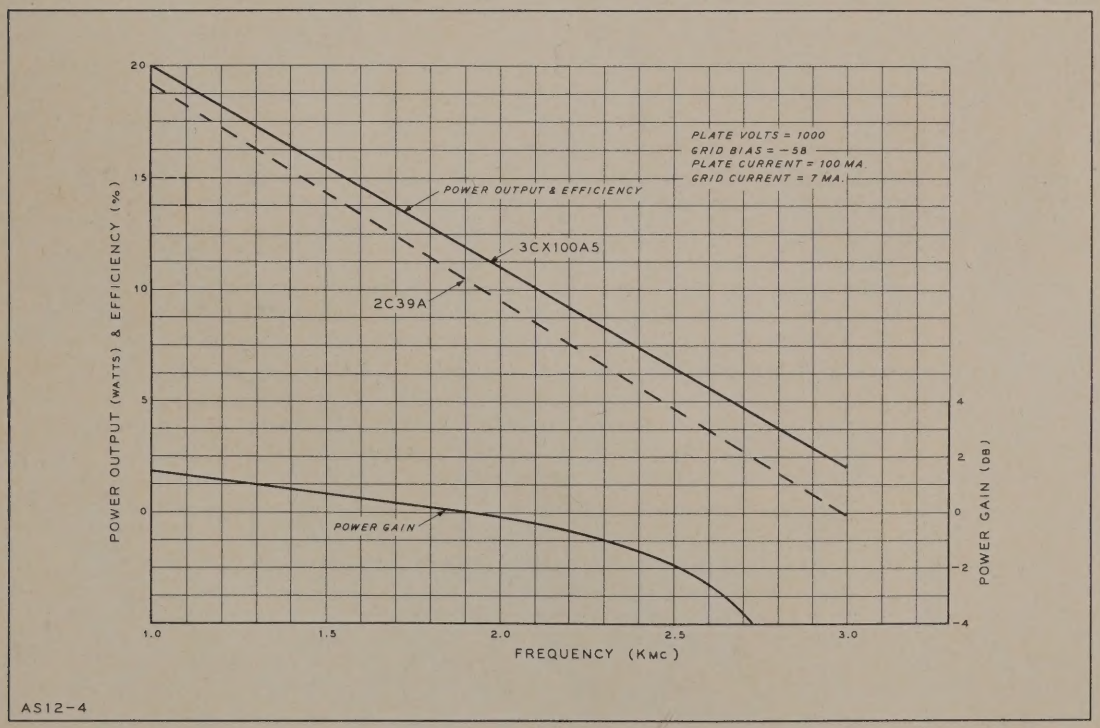

Figure 4. 3CX100A5 grounded grid tripler; typical power output, gain and efficiency. Glass 2C39A power output shown by dashed line.

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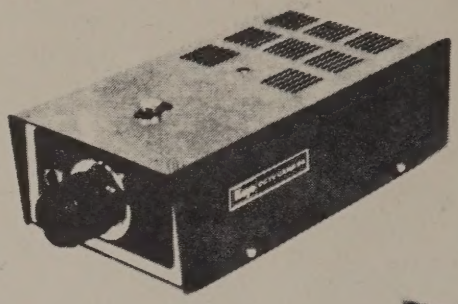

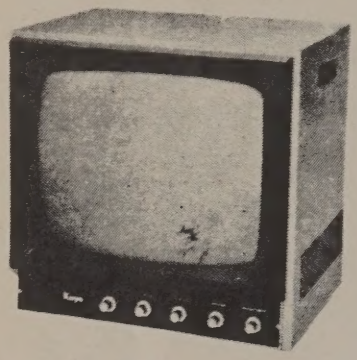

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